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THIRTY-SIXTH

PROGRESS REPORT

OF

THE FIRESTONE TIRE & RUBBER COMPANY

ON

BATTALION ANTI-TANK PROJECT

UNDER

Contract Nos. DA-33-019-ORD-33
DA-33-019-ORD-1202

ORDNANCE DEPARTMENT PROJECTS

TS4-4020—WEAPONS AND ACCESSORIES

TM1-1540—AMMUNITION

COPY No. 2

THE FIRESTONE TIRE & RUBBER COMPANY
Defense Research Division
Akron, Ohio

JULY 1953

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THIRTY-SIXTH

PROGRESS REPORT

OF

THE FIRESTONE TIRE & RUBBER CO.

ON

BATTALION ANTI-TANK PROJECT

Contract Nos.
DA-33-019-ORD-33 (Negotiated)
DA-33-019-ORD-1202

RAD Nos. ORDTS 1-12383
ORDTS 3-3955
ORDTS 3-3957
ORDTA 3-3952

THE FIRESTONE TIRE & RUBBER CO.
Defense Research Division
Akron, Ohio

JULY, 1953

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INDEX

	Page
I. Abstract	1
II. The Weapon System	2
III. T119 Projectile	14
IV. T171 Projectile	21
V. Penetration Studies	27
VI. Fuzes	38
VII. Manufacturing Summary	40

ABSTRACT

The design of a 90mm BAT weapon system to fire a T119 type projectile weighing 12 pounds, has been completed. The proposed weapon is illustrated and its ballistic characteristics are discussed.

The use of a multiple-position bias angle system for extending the useful range (range for which mismatch is within reasonable limits) is presented. Calculations are summarized for several specific cases.

The mount and remote control firing system for the ONTOS vehicle have been completed. The assembly is illustrated and the remote control operation is described.

The data are presented for an evaluation study of an M5 propellent using a T170E1 rifle and a T119E11 projectile.

A preliminary study was made of the trajectory of the T119E11 projectile close to the gun muzzle. The test results are presented and discussed.

Twenty-six rounds of T119E11 projectiles with zinc ogives were fired to evaluate the strength of the ogive and to establish the accuracy of T119E11 with this ogive. Range data are given.

Three modifications of the T171 projectile were fired for accuracy at a 1000-yard range. The projectiles are illustrated, the range data are presented and the test results are analyzed.

In the penetration program the scaling studies were continued. The studies are based upon sharp apex cones scaled in accordance with charge diameters of 2.5, 3.0 and 3.5 inches. Data for scaling the effect of standoff and rotation on penetration are presented.

A test was conducted to determine the functioning of T267E14 base elements. Although the superquick functioning of this fuze is satisfactory certain changes in the delay element appear to be necessary and these are illustrated.

THE WEAPON SYSTEM

Ultimate BAT System

The requirements for an ultimate BAT system and approaches to attaining these requirements were discussed in the Thirty-Third Progress Report. The approach which has been selected for immediate action is the development of a 90mm rifle which will fire a 12-pound T119 type projectile at a muzzle velocity of 2200 fps. This weapon, Fig. 2, appears to be a reasonable compromise of the requirements for accuracy, penetration and weight.

Ballistic Characteristics of the 90 mm Rifle

The rifle has a chamber volume of approximately 400 cu in. Interior ballistic calculations indicate that a charge of 7 lb. 14 oz. of MPM10 .044-inch web propellent will produce a muzzle velocity of 2200 fps and a maximum pressure of 15,000 psi with a 12 lb. projectile. The length of projectile travel required, from interior ballistic calculations, is 111 inches. The pressure-travel and velocity-travel curves as obtained from interior ballistic calculations, are shown in Fig. 1.

Design Considerations

The 90mm rifle has been designed to withstand a pressure of 23,500 psi. Two chambers with different contours have been designed to study the effect of chamber configuration on recoil. Figs. 3 and 4 are drawings (DRF75 & 82) of the two chamber contours to be evaluated. A smooth bore and a rifled tube are being manufactured.

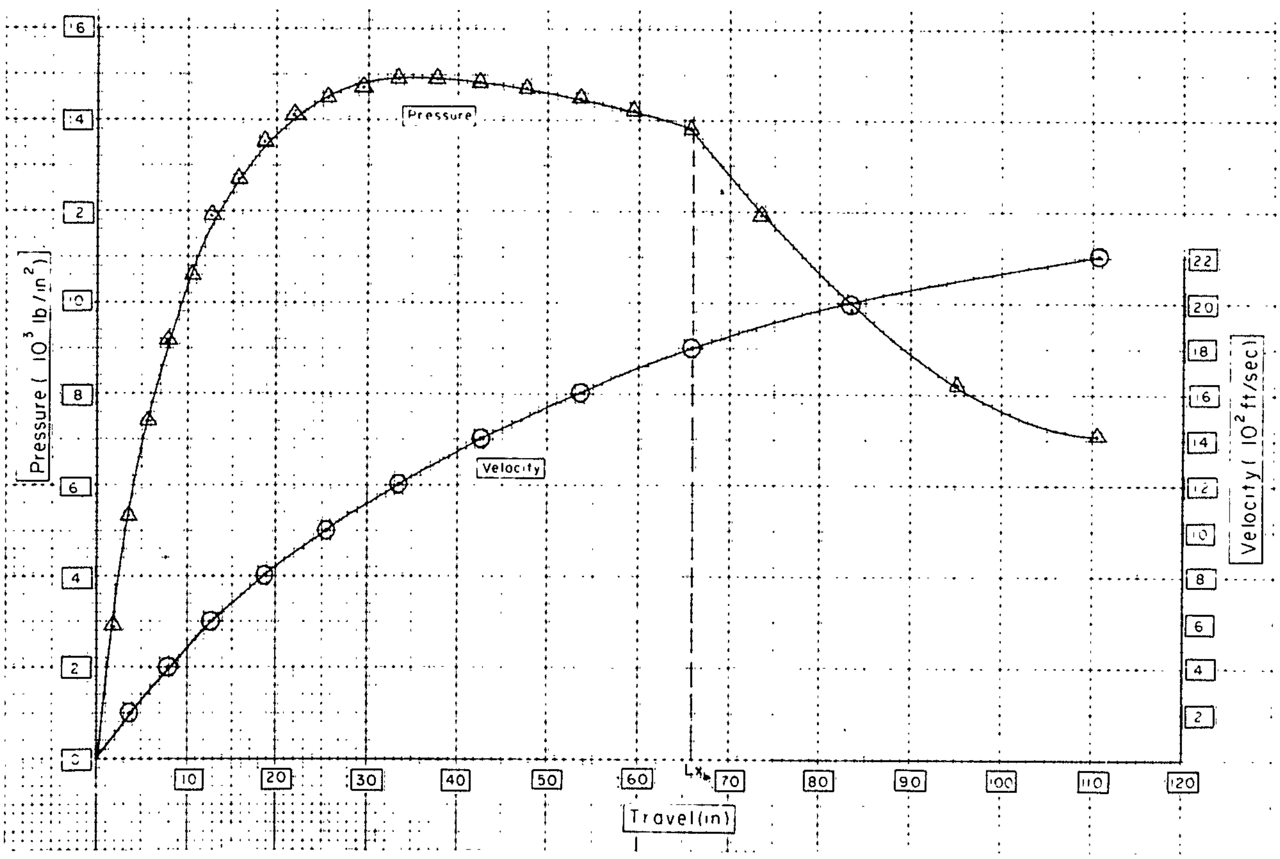


Fig. 1. Pressure-Travel and Velocity-Travel Curves.
For 90 mm BAT Recoilless Rifle.

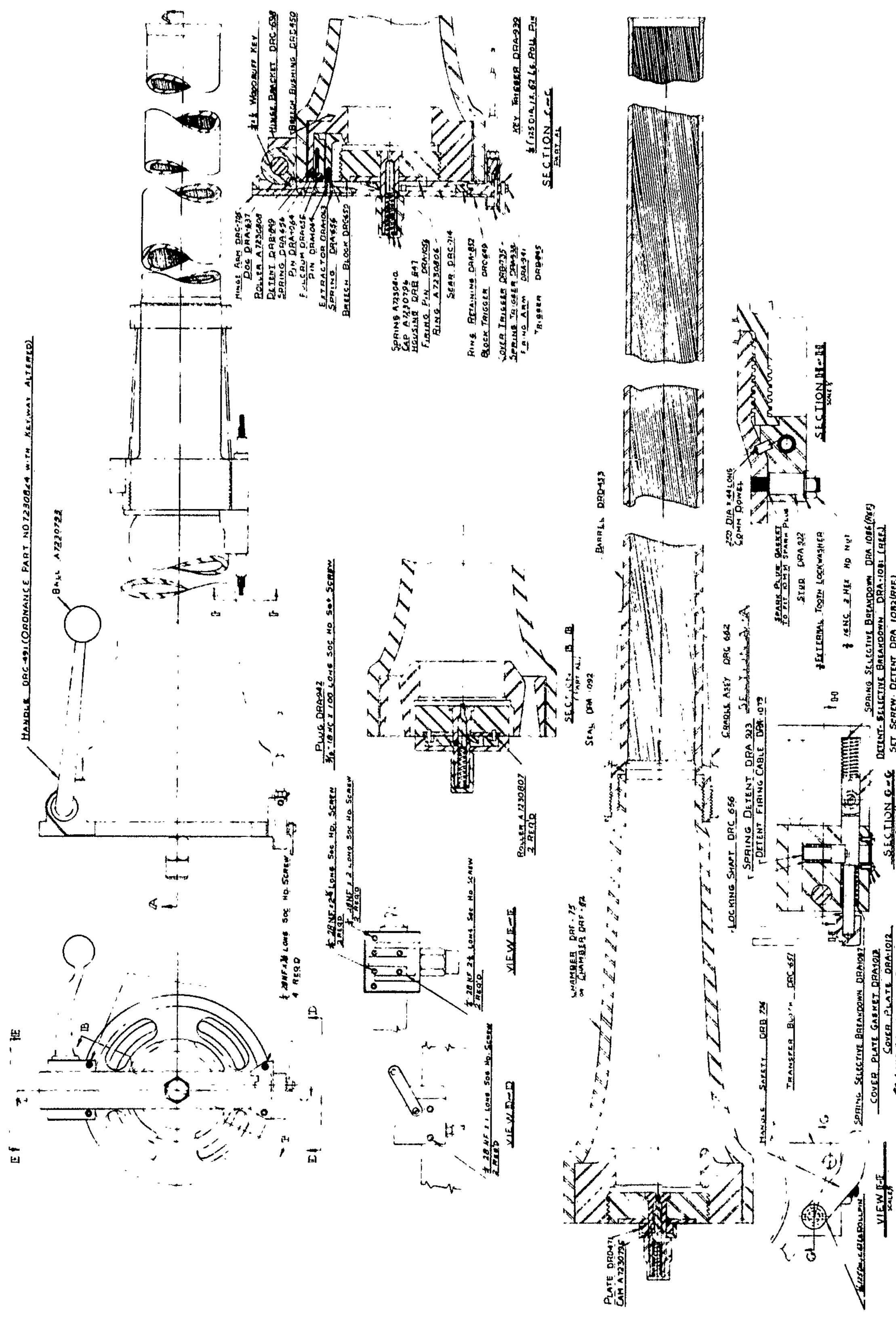


Fig. 2. 90 mm Recoilless Rifle.
Firestone Drawing No. DRF 77-3.

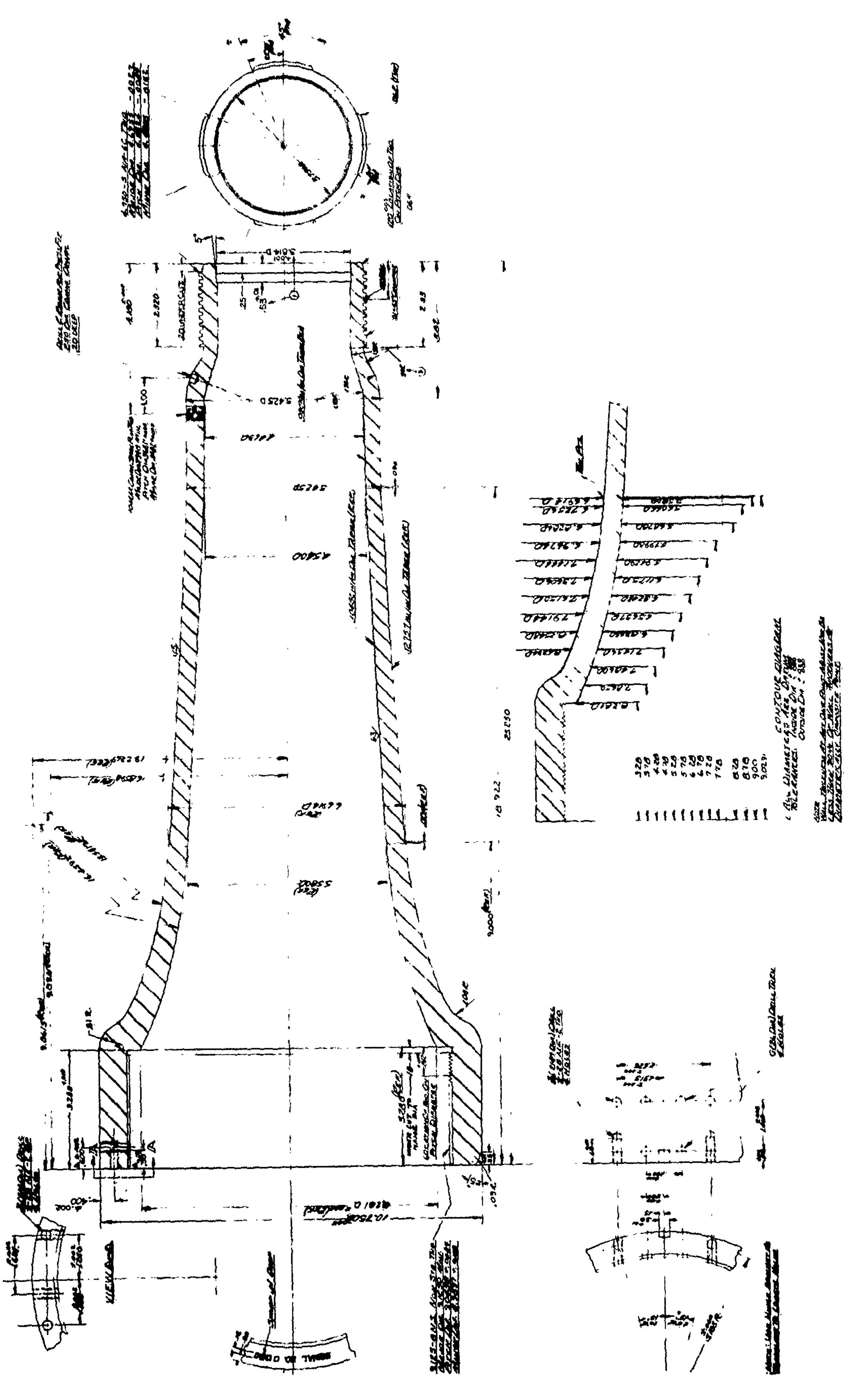


Fig. 3. 90 mm Rifle Chamber.
Firestone Drawing DRF 75-4.

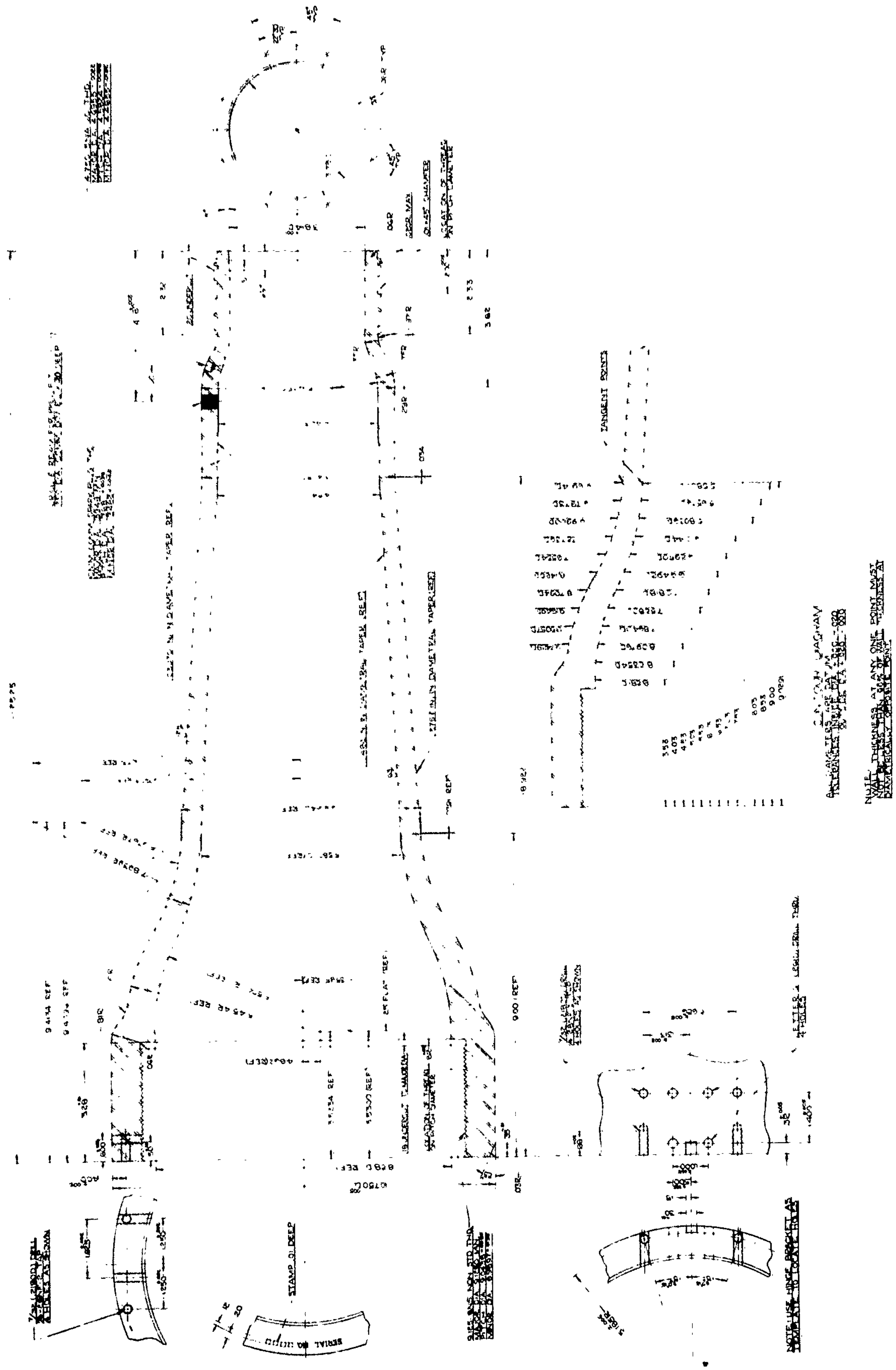


Fig. 4. 90 mm Rifle Chamber.
Firestone Drawing DRF 82.

Spotting Bullet

The Thirty-Third Progress Report discussed the use of a 20mm spotting bullet and presented a theoretical example which produced a satisfactory match with a 90mm T119 type projectile. Further efforts have been made to improve the spotting rifle as a range finder from the theoretical considerations.

For the interim BAT weapon the spotting bullet has been matched reasonably well with the major caliber projectile at ranges up to 1200 yards but beyond this range the mismatch has become unreasonable. It has been proposed to use some sort of device with the BAT weapon system to provide a variable bias. A continuously variable bias presents very difficult mechanical problems when firing at elevated targets (from a valley to a hilltop). The elevation angle used when firing at elevated targets would be different from the true elevation angle required to obtain the true range. The biasing device would then not be able to provide the correct bias angle for the given range if the device was connected to the elevating mechanism.

A more practical type of variable biasing device appears to be one which will provide for two or three bias angles. The bias angles selected for this device would produce reasonably small mismatch with overlapping ranges. The gunner would be required to estimate the range of his target so as to select the proper bias angle. If the bias angles were such that the ranges for each could overlap appreciably, the gunner's estimation of range need not be too accurate.

The caliber .60 API-T has been proposed for use as a spotting bullet. Calculations have been made to determine the bias angles required from 400 to 2000 yards to obtain a mismatch of less than 18 inches absolute with a 90mm T119 type projectile and this caliber .60 bullet. This type of relation was determined to explore the feasibility of using a variable bias of the two or three position type with the caliber .60 bullet. Fig. 5 is a graph of bias angle vs. range for the caliber .60 API-T bullet fired at 2920 fps and the T119 projectile fired at 2200 fps. The

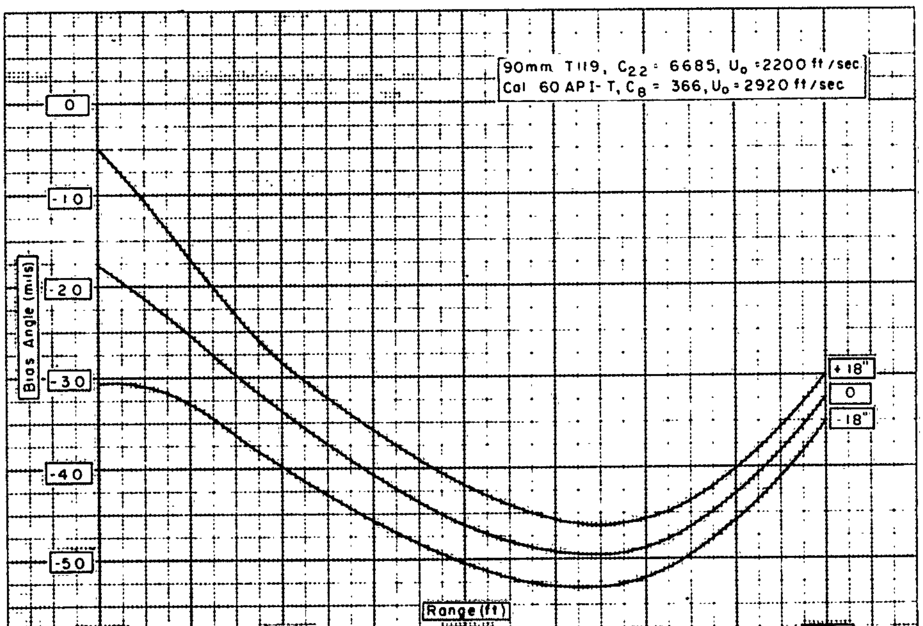


Fig. 5. Bias Angles.
For Matching Trajectories of 90mm, T119, and Cal. .60 API-T.

graph shows that this caliber .60 bullet could not be successfully used with T119 type projectile under consideration, since too many bias angle adjustments would be required to stay within the 18-inch mismatch range.

Fig. 6 is an example of a two-position bias. The caliber .50 T189 spotting bullet is fired at 2710 fps with a 90mm T119 type projectile having a muzzle velocity of 2200 fps. Although more range overlap is desirable the mismatch is less than 18 inches absolute from 400 to 1030 yards using a bias angle of -2.65 mils and from 1000 to 2000 yards with a bias angle of -3.60 mils.

Fig. 7 shows the bias angles for matching the trajectory or obtaining less than 18 inches absolute mismatch between 400 and 2000 yards using a caliber .50 T189

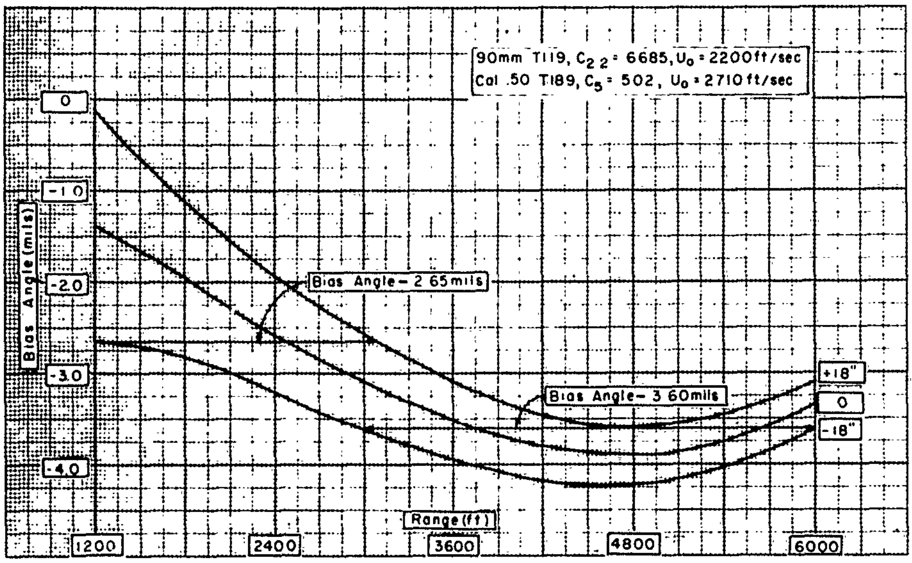


Fig. 6. Bias Angles.
For Matching Trajectories of 90 mm, T119 and Cal. .50, T189.

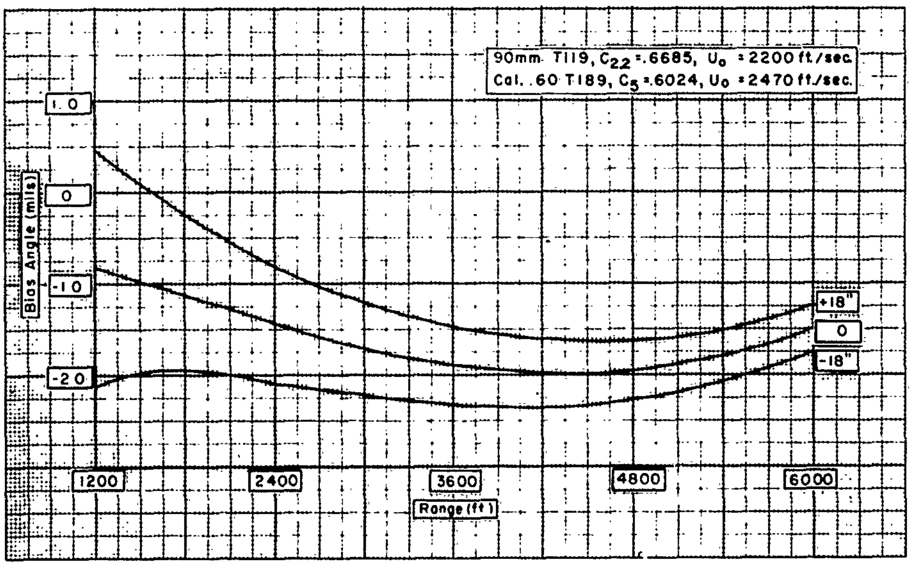


Fig. 7. Bias Angles.
For Matching Trajectories of 90 mm, T119 and Cal. .60, T189.

spotting bullet scaled up to caliber .60 and fired at 2470 fps. For less than 18 inches absolute mismatch, one bias angle of -1.75 mils can be used over the entire range.

Fig. 8 shows the vertical mismatch as a function of range for the bias angle of -1.75 mils using the caliber .60 T189 type spotting bullet and the 90mm T119 type projectile fired at 2470 and 2200 fps, respectively.

It has also been proposed to increase the muzzle velocity of the 90mm T119 type projectile to 2400 fps. Figs. 9 and 10 present the bias angles and mismatch as a function of range for this major caliber muzzle velocity using the caliber .60 T189 type spotting bullet fired at 2705 fps. A bias angle of 1.58 mils can be used to give a mismatch of 18 inches absolute or less, from 400 to 2000 yards.

The above mismatch calculations in-

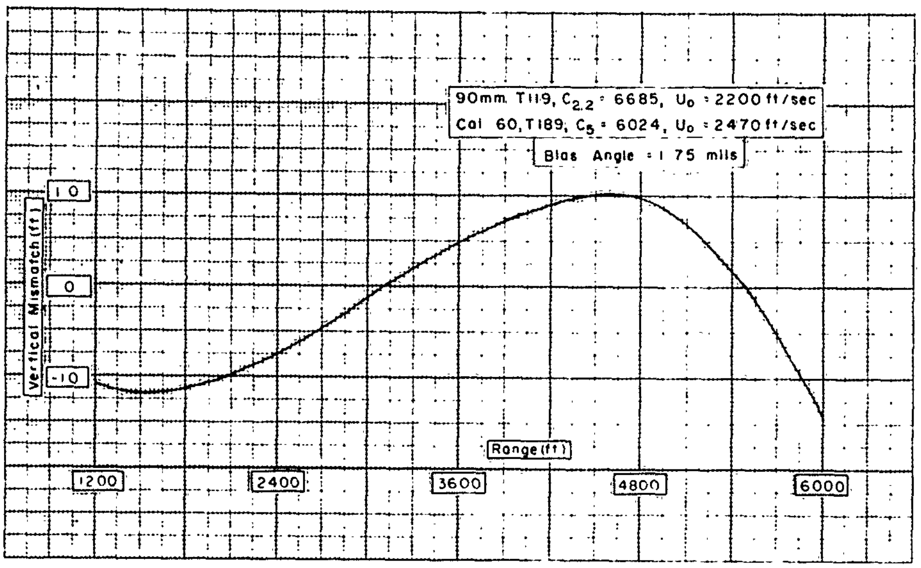


Fig. 8. Vertical Mismatch As a Function of Range.
For 90 mm, T119 and Cal. .60, T189.

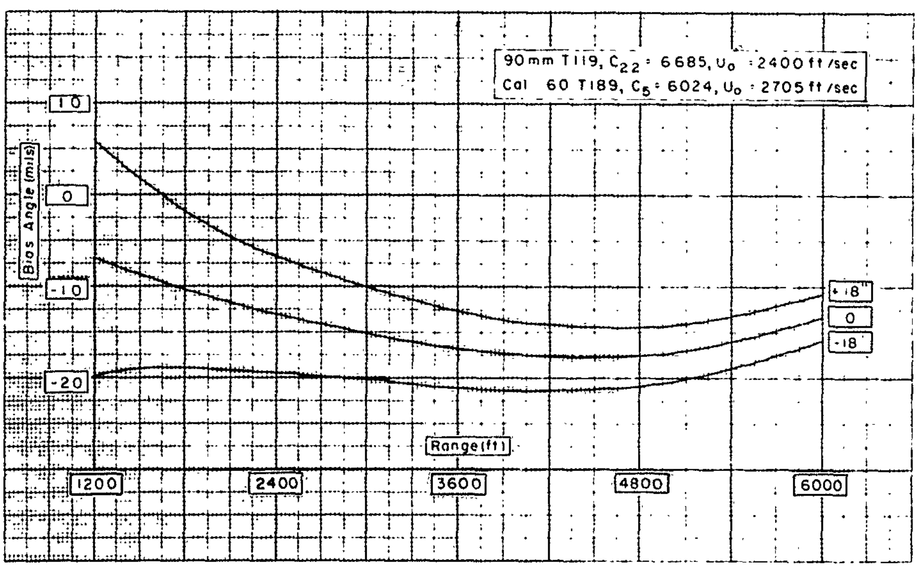


Fig. 9. Bias Angles.
For Matching Trajectories of 90 mm, T119 and Cal. .60, T189.

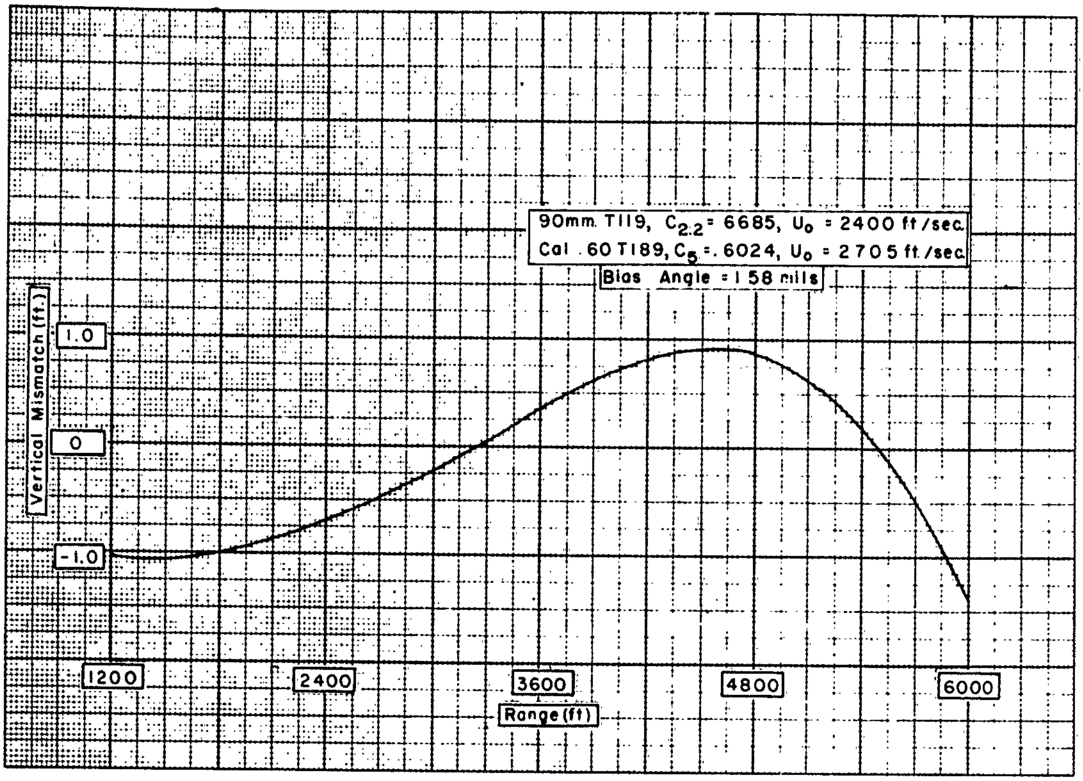


Fig. 10. Vertical Mismatch As a Function of Range.
For 90 mm, T119 and Cal. .60, T189.

volve only the vertical mismatch. The problems of horizontal mismatch are under consideration at the present time.

The Ballistic Research Laboratories method of least squares was used to minimize mismatch with respect to muzzle velocity and bias angle. Siacci functions were used to calculate the firing tables required for the mismatch and bias angle calculations.

ONTOS Mount and Firing System

The mount and remote control firing system for the ONTOS vehicle, under development by this division for the past several months, have been completed. Fig. 11 is a photograph of the system which is scheduled for shipment to Aberdeen Proving Ground for testing during the first week of August, 1953.

This system mounts six T170E1 rifles, a cluster of three on each side, on the ONTOS vehicle. Each weapon is equipped with a spotting rifle and each weapon unit is clamped to the trunnion bracket by a quick-disconnect similar to that used on the BAT mount. The remote control firing system permits the gunner to open or close the breech or to fire any rifle he wishes without leaving the firing panel inside the vehicle. The control mechanism is housed in the control panel which is approximately 6 in x 8 in x 12 in. The power required for this control system is supplied by the 24-volt battery system of the vehicle.

In order to maintain the overall height and width of the previous ONTOS systems it was necessary to design a new rear spotting rifle bracket and sight mounting pad. The new two-piece bracket is shown in Fig. 12 where the original bracket is also shown for comparison. This bracket provides for quick removal of the sight.

The design of the electrical firing sys-

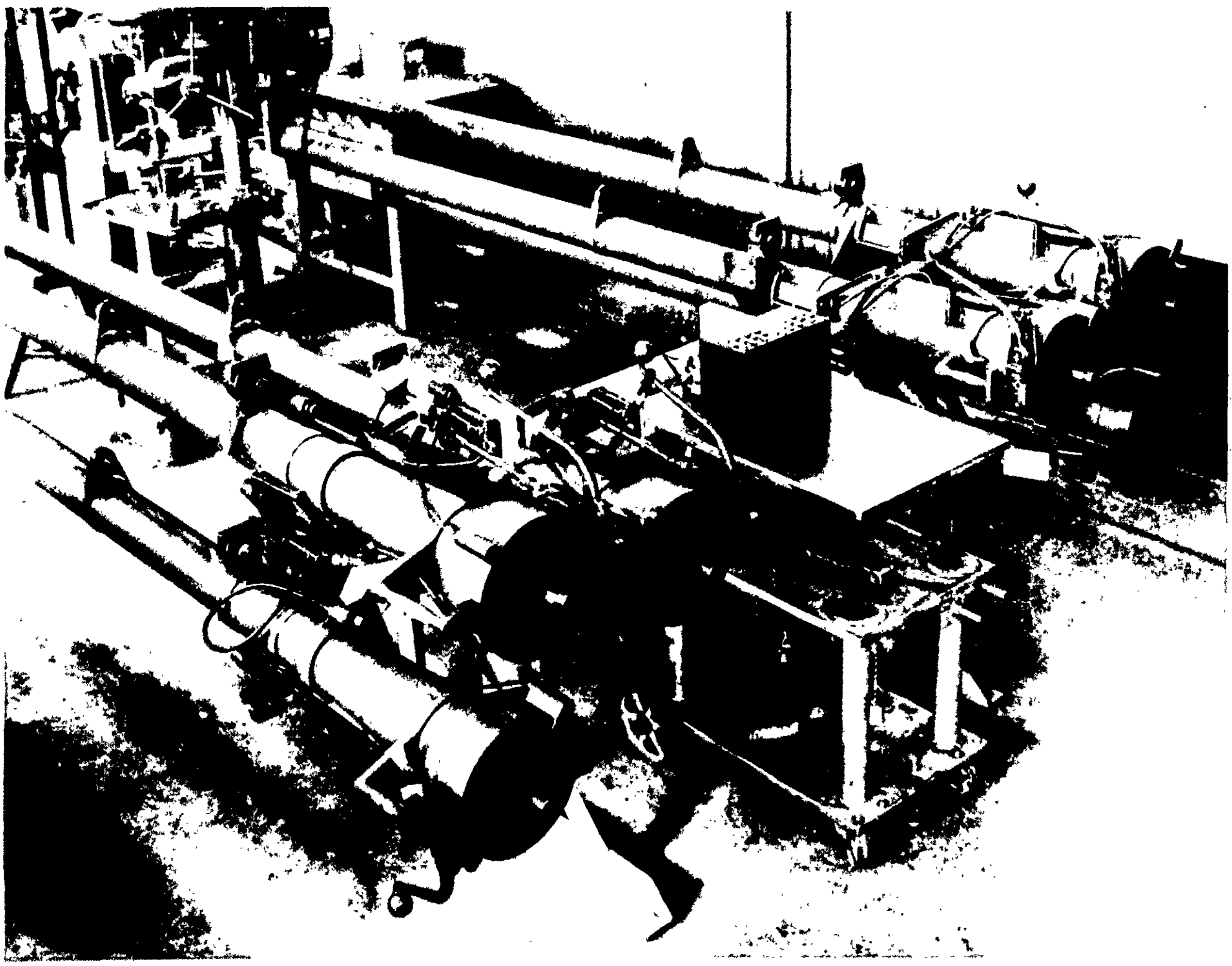


Fig. 11. ONTOS Firing System.

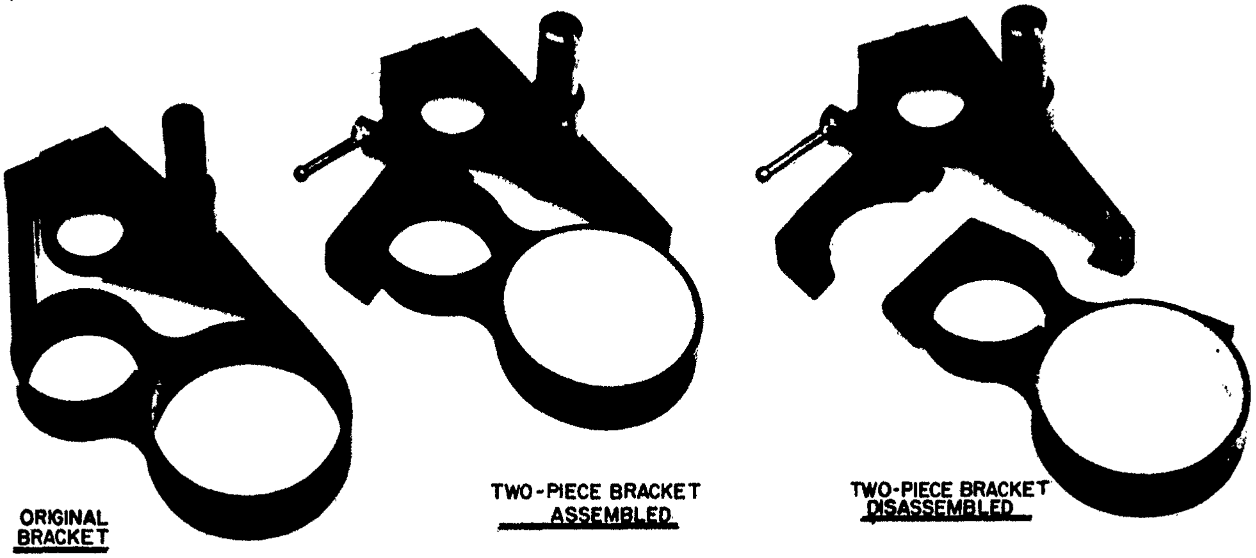


Fig. 12. Rear Spotting Rifle Bracket and Sight Mounting Pad.
Original Bracket and New Two-Piece Bracket.

tem has the following features:

1. Permits the use of standard BAT weapons.

2. Provides a means for closing the breeches from inside the vehicle.

3. Provides a reliable means of firing the 105mm rifles in any combination of 6.

4. Provides a reliable means of firing spotting rifles in any combination of 6.

5. Provides an indicator system which lets the gunner know which 105mm rifles have been fired.

The rifle breeches are closed by a Lear Inc. linear actuator which is fastened to the main trunnion bracket. It is so arranged that the breech is closed manually to the half-cocked position. From this position all six breeches are fully closed or opened to the half-cocked or safe position by the linear actuators. As a safety measure all breeches operate together.

Firing is accomplished by a Lear Inc. rotary actuator which is incorporated as part of the lower half of the quick - disconnect bracket. By means of a selector switch on the control panel either the 105mm or caliber .50 rifles may be fired and the gunner may fire any combination of the six 105mm rifles and the caliber .50 rifles.

Indicator lights are so arranged that when all breeches are locked, ready to fire, a red light, comes on for each individual rifle. If no firing is done and the breeches are opened to the half-cocked or safe position, the red lights go out and green lights come on (when the breeches reach the safe position).

The indicator system, for determining when a 105mm rifle has fired, is operated by a blast switch fastened to the rear of each rifle breech. If a 105mm rifle fires the blast gases emitting from the vents close the switch which turns off the red light and turns on the green, indicating a safe rifle. Thus, at any time during a firing sequence the gunner may tell which rifles are still loaded by counting the red lights still showing on the panel. The number of green lights showing indicate the number of rifles fired.

Evaluation of M5 Propellent

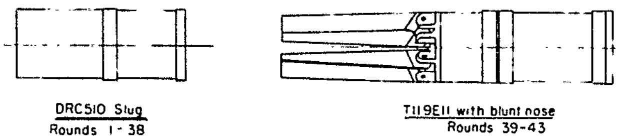
A firing program was conducted to evaluate an M5 propellent for use in the T170E1 rifle with the T119E11 projectile. Table I contains the firing data and Figs. 13 and 14 give a graphical summary of the data.

Thirty-eight rounds were fired using proof slugs, DRC510, shown in Table I, and using RAD16415 (M5) and PA30252 (M10) propellents. A charge of 7 lb-4 1/2 oz of RAD16415 (M5) resulted in an average muzzle velocity (20 rounds, Rds. 10-29 Table I) of 1665 fps, with an average chamber pressure of 8,800 psi (M-3 Cu).

A charge of 7 lb-1 3/4 oz of PA30252 (M10) gave (for 9 rounds, Rds. 30-38, Table I) an average muzzle velocity of 1632 fps with a chamber pressure of 10,200 psi (M-3 Cu) or 1,400 fps higher pressure at 33 fps lower velocity. The temperature coefficient was 1.29 fps/ ^{o}F for the M5 propellent and 1.31 fps/^{o}F for the M10. This difference is well within experimental error.

Five rounds were fired with T119 slugs, shown in Table I, and 7 lb-4 oz charges of RAD16415 gave an average muzzle velocity (5 rounds, Rds. 39-43, Table I) of 1636 fps and an average chamber pressure of 8,000 psi.

Table I
Firing Data
Evaluation of RAD 16415 Propellent



Round No	ChargeWeight (lb-oz)	Powder Temp (Deg F)	Pressure (psi -M-3Cu)	Velocity (fps)	Recoil lb-sec	Powder Type
1	7	74	7400	1587	5	M5
2	7	74	7700	1607	9	"
3	7	74	7500	1587	0	"
4	7-4	74	8700	1647	5	"
5	7-4	74	8500	- -	2	"
6	7-4	74	8900	1645	-2	.
7	7-8	74	8400	- -	0	"
8	7-8	74	9800	1734	8	"
9	7-8	74	9200	- -	2	.
10	7-4 1/2	74	8400	1674	12	"
11	"	74	8700	1665	0	"
12	"	74	8800	1657	4	"
13	"	74	8600	1655	2	"
14	"	74	8800	1665	5	"
15	"	0	7100	1561	0	"
16	"	0	7400	1553	-5	"
17	"	0	7100	- -	- -	"
18	"	0	7700	1596	- -	"
19	"	0	7200	1568	-2	"
20	"	-28	6800	1523	-9	"
21	"	"	7000	1526	-9	"
22	"	"	7100	1523	-7	"
23	"	"	- -	1511	-5	"
24	"	"	7000	1512	-3	"
25	"	-40	7000	1507	-7	"
26	"	"	6400	- -	-15	"
27	"	"	6500	- -	-13	"
28	"	"	6500	1523	-15	"
29	"	"	6100	1541	-3	"
30	7-1 3/4	70	10200	1644	0	M10
31	"	70	10000	1631	3	"
32	"	70	10500	1639	2	"
33	"	70	10200	1614	0	"
34	.	-40	7400	- -	-3	"
35	"	"	7600	1492	-1	"
36	"	"	7500	1484	-5	"
37	"	"	7200	- -	-6	M10
38	"	"	7600	- -	-7	"
39	7-4	70	8200	1623	17	M5
40	"	"	7500	1631	21	"
41	"	"	7800	1634	19	"
42	"	"	8400	1642	19	"
43	"	"	8300	1639	15	"

Notes:
1. Rounds No. 1 - 38 were DRC510 slugs.
2. Rounds No. 39 - 43 were T119E11, blunt nose projectiles.
3. Rounds No. 1 - 38 fired in 106mm Rifle , T170E1 Serial No. 50.
4. Rounds 39 - 41 fired in 106mm Rifle T170E1 Serial No. 53.
5. Rounds 42 - 43 fired in 106mm Rifle T170E1 Serial No. 54.

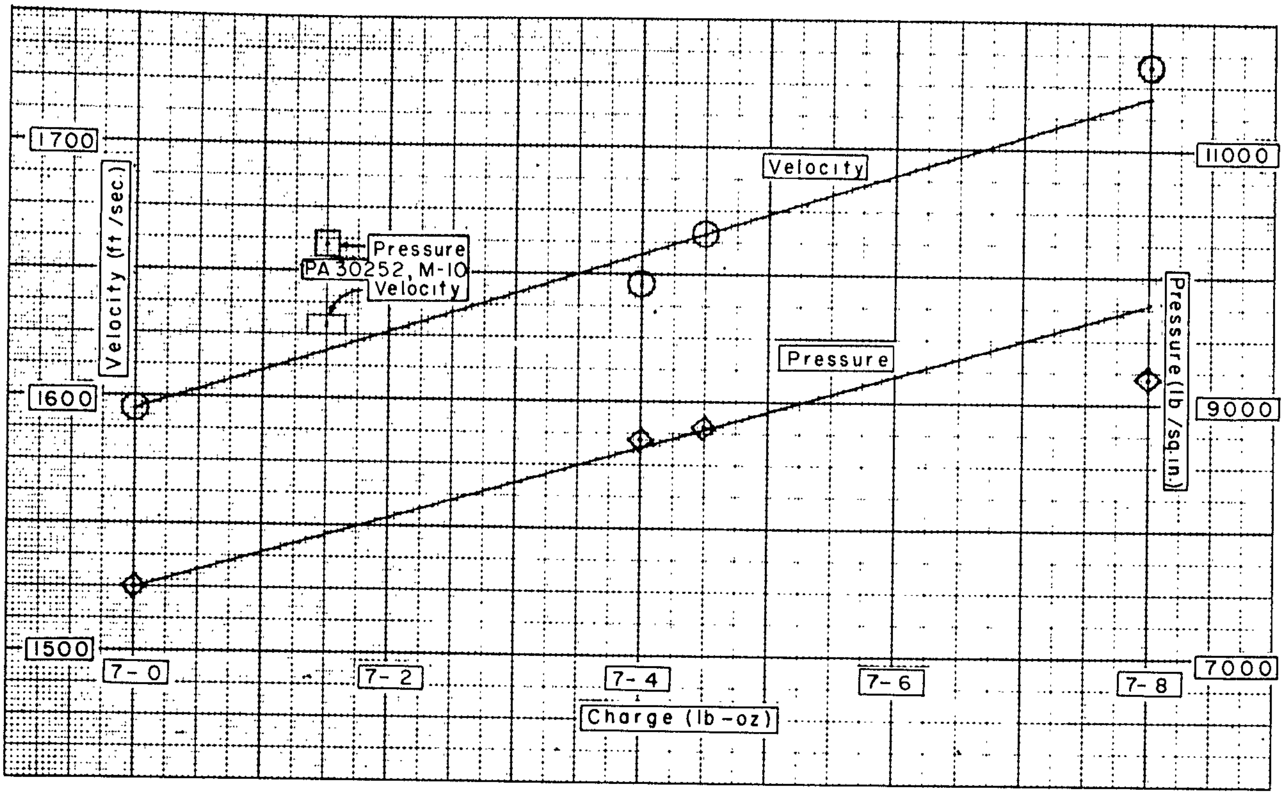


Fig. 13. Charge-Pressure and Charge-Velocity Curves.
RAD 16415 (M5), MP, .040-inch Web.

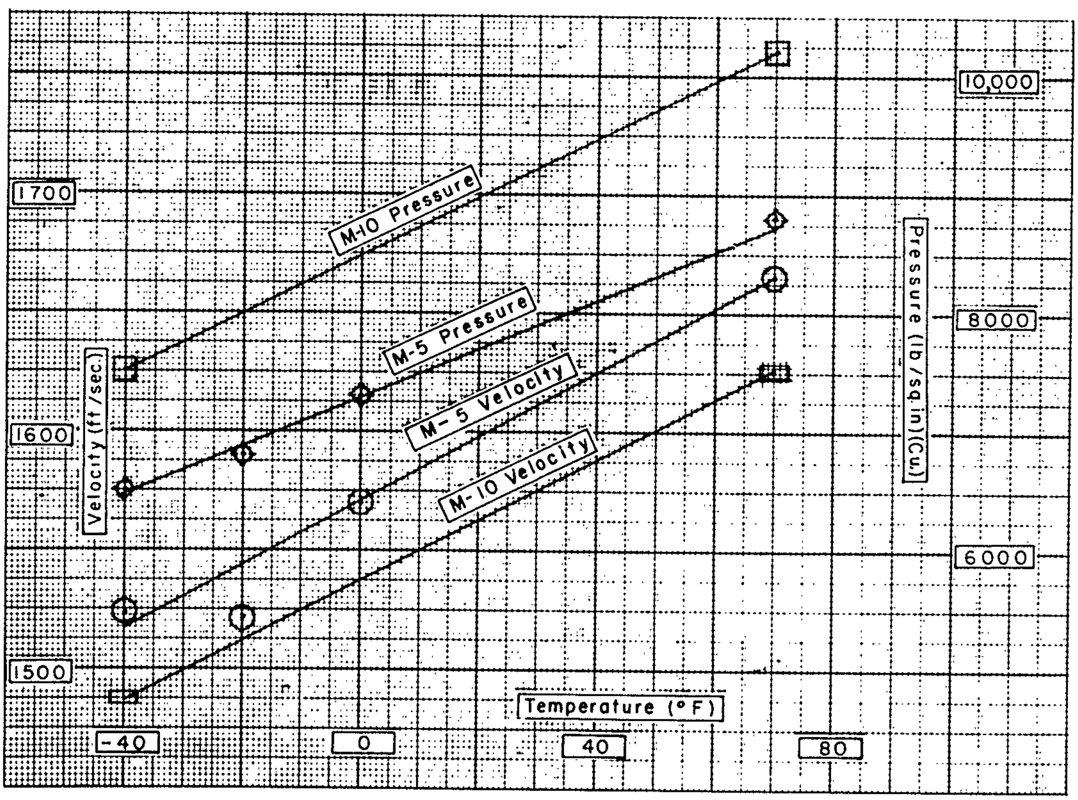


Fig. 14. Temperature Versus Velocity, Pressure.
RAD 16415 (M5) and PA 30252 (M10).

Initial Trajectory

In an effort to determine the trajectory of the T119E11 projectile just after leaving the muzzle, five rounds were fired through a series of nine cardboard yaw cards placed at distances from 30 ft to 288.7 ft down range from the muzzle of the T137E2 gun. The procedure followed was to elevate the gun for impact on an 18 ft by 18 ft target at 1055 yards, set up and mark the sight line on the ninth card, and continue in the same manner with each of the other eight cards. After each round the impact on each card was measured and the cards replaced. The impact points are recorded in Table II and the successive impacts of each round appear in Figs. 15 through 19. The firing record for these rounds was presented in the Thirty-Fifth Progress Report (Table IV, page 10).

Table II
Trajectory Close To The Gun Muzzle
Position of Individual Impacts On Nine Yaw Cards

Card Number	Distance from Muzzle (ft.)	Position of Impact (inches)									
		Projectile X362		Projectile X364		Projectile X365		Projectile X368		Projectile X370	
		Vert	Horiz	Vert	Horiz.	Vert	Horiz.	Vert	Horiz	Vert	Horiz.
1	30.0	-.55	-.64	-.30	+.39	-.30	+1.08	-.25	+.48	-.04	+.31
2	60.0	-.05	+.28	-.31	+1.34	-.42	+1.48	-1.27	+1.34	-.44	+.19
3	70.8	+.02	+.67	-.55	+1.95	+.05	+2.24	-2.53	+1.38	-.48	+1.59
4	81.0	-.39	+.73	-.59	+2.20	+.22	+1.27	-2.84	+1.69	-.26	+1.09
5	110.7	+.45	+1.73	-1.00	+.80	+.66	+2.56	-3.58	+1.84	-.42	+1.64
6	121.4	-.47	+1.06	-.05	+3.44	-.88	+1.70	-3.95	+1.92	+.77	-1.75
7	130.6	+.28	-.45	-1.59	+3.25	-.70	+3.05	-3.58	+2.80	-.80	+.89
8	157.4	-.88	+.41	-.73	+3.05	-1.27	+2.92	-4.39	+3.44	-2.13	+2.50
9	288.7	-4.02	+.05	-7.05	+3.73	-5.31	+6.44	-8.17	+7.77	-4.02	+4.33

Note: The yaw card impact points are given with reference to the sight line.

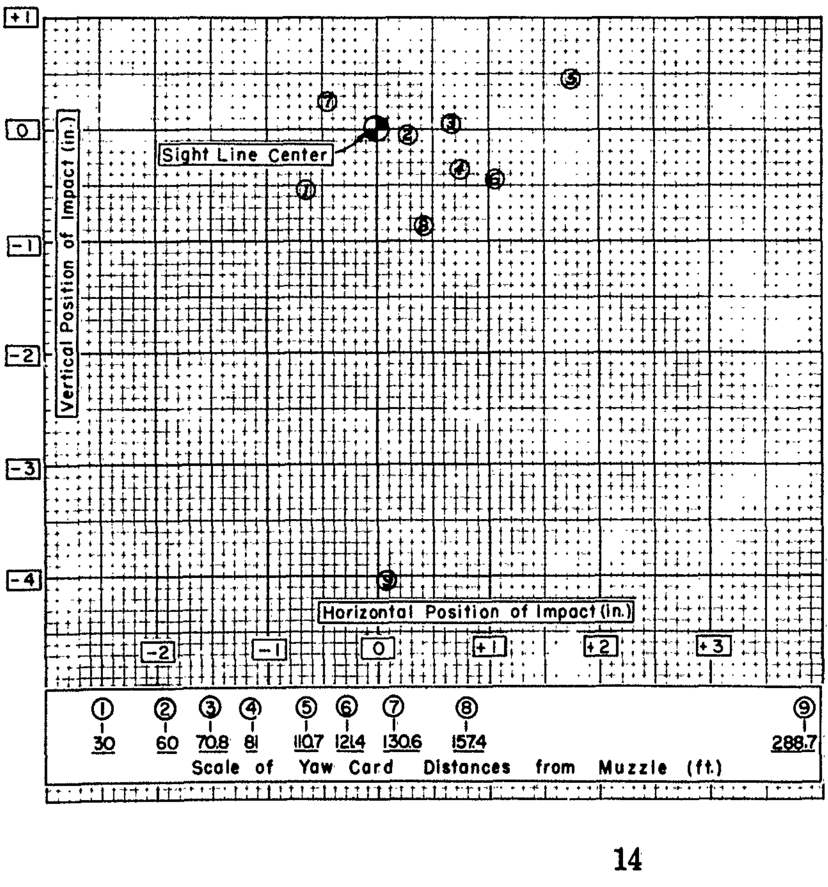


Fig. 15. Yaw Card Impact Points.
For T119E11 Projectile X362.

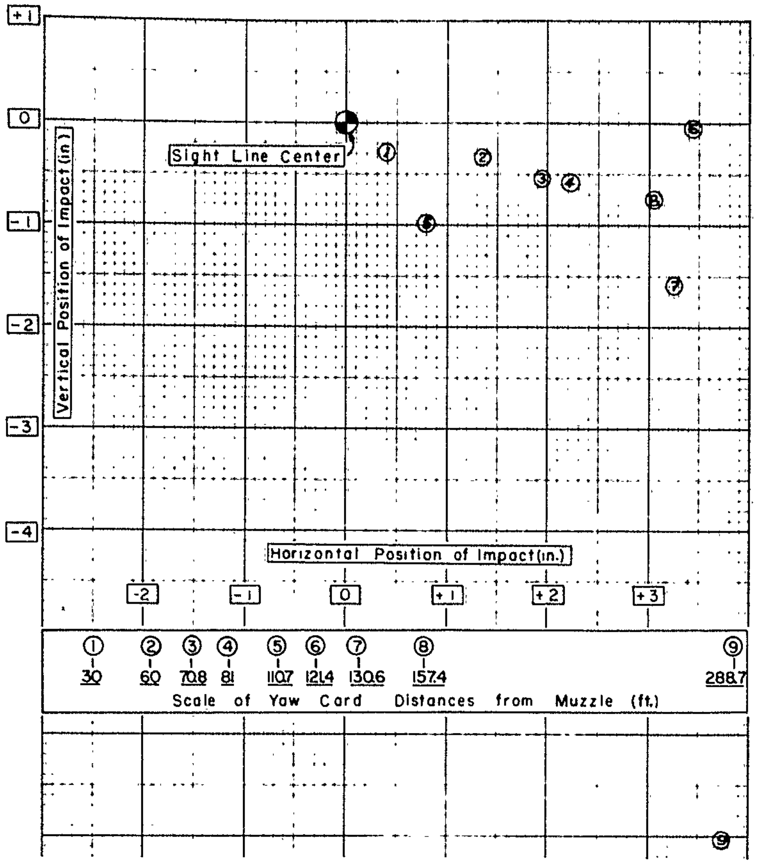


Fig. 16. Yaw Card Impact Points.
For T119E11 Projectile X364.

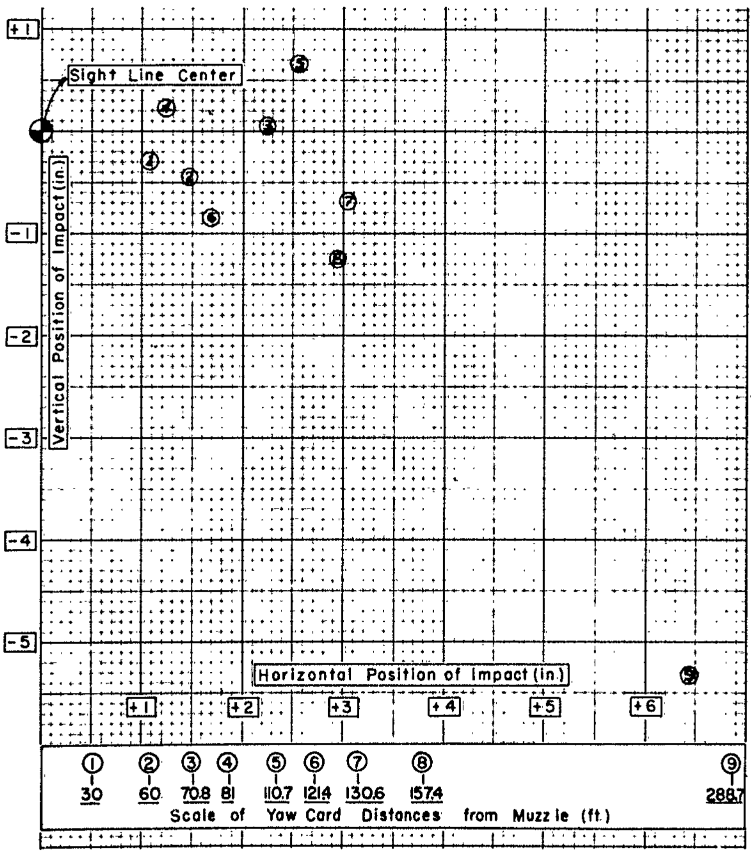


Fig. 17. Yaw Card Impact Points.
For T119E11 Projectile X365.

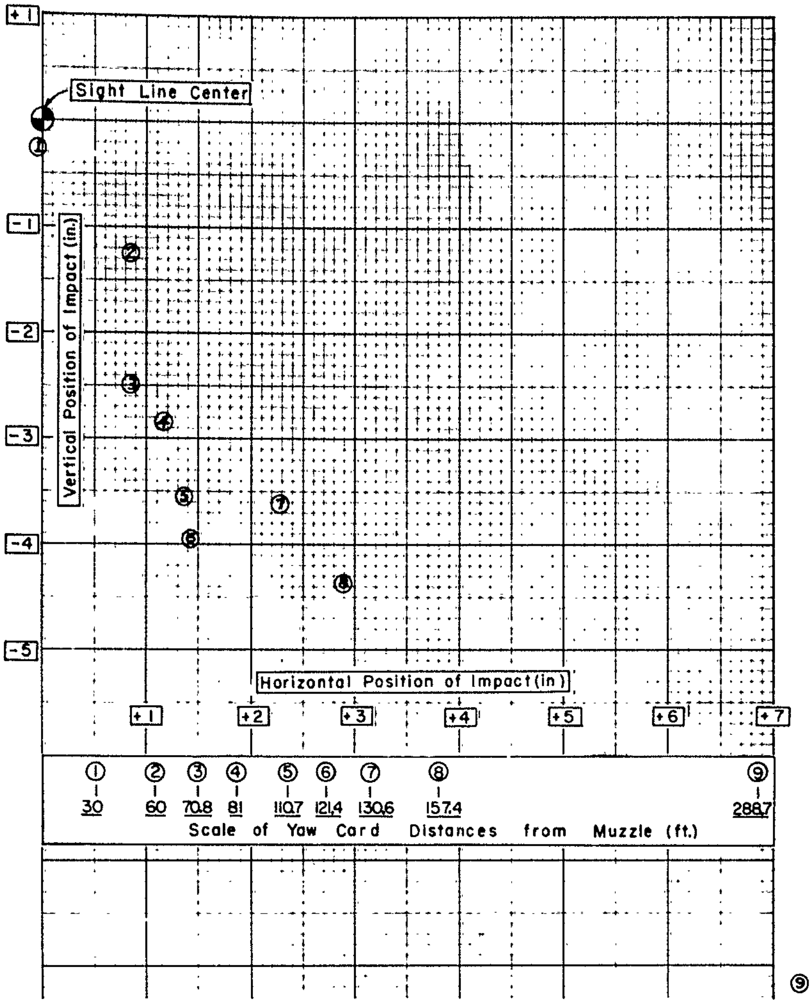


Fig. 18. Yaw Card Impact Points.
For T119E11 Projectile X368.

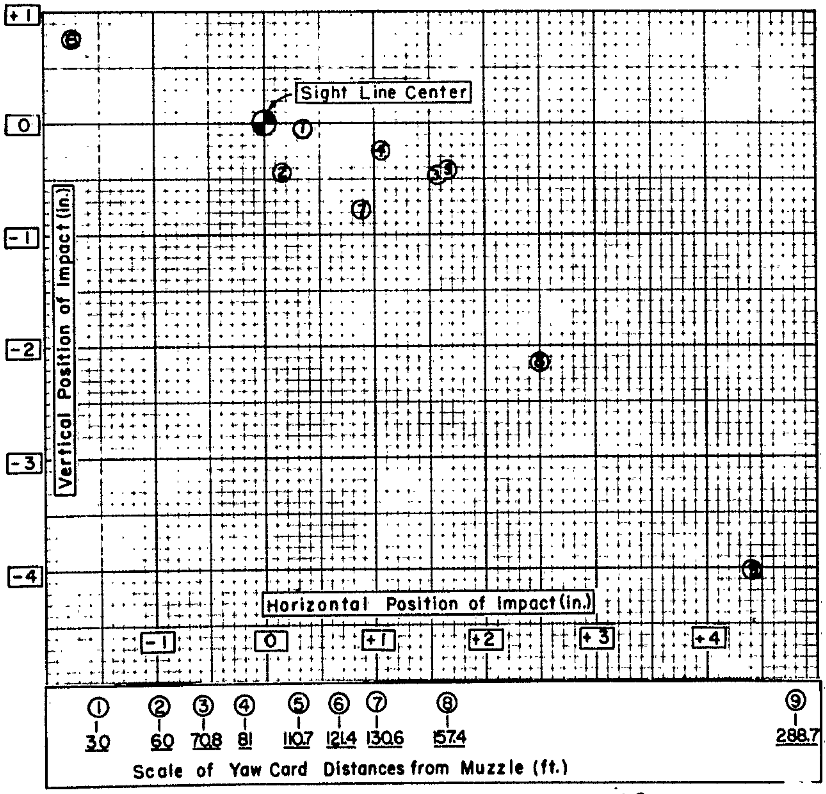


Fig. 19. Yaw Card Impact Points.
For T119E11 Projectile X370.

In studying the plots showing the combined impact points from the nine yaw cards for each of the five projectiles, it must be remembered that the data have not been corrected for the normal projectile drop, e.g. departure of the true trajectory from the line of sight (approximately 6 inches, 300 ft from the muzzle). Study of these yaw cards also suggests that during the early stages of their flight the projectiles have a precessing motion which might result from muzzle blast or other conditions of launching. An extensive program is being planned to more exactly define the early trajectory.

Evaluation of Zinc Ogive

Nineteen T119E11 projectiles with zinc ogives were fired at Erie Ordnance Depot for evaluation of the ogive.

Strength Test - Five projectiles were fired at excess pressures, through yaw cards, into a recovery box. In an attempt to improve recovery of the projectiles, the ogive caps were replaced by aluminum spoiler disks. The purpose of the spoiler disk was to reduce the nose lift and minimize swerving of the projectile in the sawdust of the recovery box. The range data are given in Table III.

Yaw card data for all five rounds indicate no evidence of failure of the ogive. Fastax photographs which were obtained for two rounds (5172 and 5173) also showed the zinc ogive to be intact after launching. The spoiler disks apparently separated from the ogives on impact and failed to prevent extensive damage to the projectiles caused from contact with the steel sidewalls of the recovery box.

Low Temperature Test - Four projectiles conditioned at -40° F were fired, two through yaw cards and down range and one for recovery. The range data are given in Table III.

The three projectiles fired down range were observed to have good flight. The recovered projectile was badly damaged; however, no failure of the zinc ogive could be detected on the yaw cards.

Satisfactory performance of the zinc ogives at -40°F was confirmed by Fastax photographs of all four rounds. A typical photograph is shown in Fig. 20 for projectile number X693.

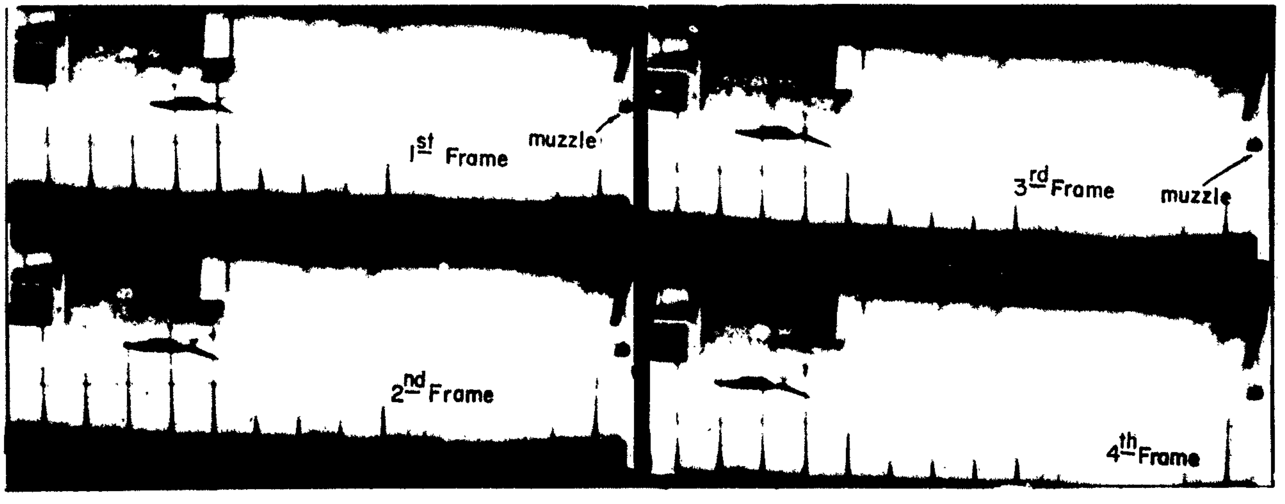


Fig. 20. Typical Fastax Photograph.
T119E11 Projectile X693

Accuracy Program - An accuracy program involving projectiles with zinc ogives was fired. The third round fired damaged the target and when firing was resumed the following day a group of seven rounds were fired. The probable errors of dispersion for the seven rounds were V.P.E. = ±.44 mil and H.P.E.=±.44 mil. The first three rounds fired on the first day (Table IV) were not used in the probable error calculations. Table IV is the firing record for this program.

These tests show that the zinc ogive has adequate strength both at ambient and low temperatures. The accuracy obtained with projectiles with zinc ogives was equivalent to the accuracy of the standard T119E11.

Future Program

1. A program to evaluate a short tail assembly for the T119 projectile has been started. The new design results in a stronger tail assembly than that of the present T119E11 projectile.

2. Twenty-five T119E11 projectiles with zinc ogives are being loaded at Picatinny Arsenal. The rounds will be fired at Aberdeen Proving Ground to test the effect of the zinc ogive on penetration.

3. Projectiles will be assembled with short and long ogives to determine the effect of ogive length upon accuracy. Tests will follow.

4. Twenty T119E11 projectiles are being assembled to study the effect of relaxed tolerances in the fin assembly. These projectiles will be fired to determine both mechanical and flight behavior.

5. Twenty special housings with an O.D. of 4.118 - .005 are being machined. This design should permit the projectile to emerge from the barrel more smoothly than it does at present.

6. It is planned to fire T119 projectiles with several different types of obturating bands. There is evidence to indicate that the launching of the projectile might be improved with better obturation and increased muzzle spin.

Table III
Range Data
To Test Strength of Zinc Ogive At Excessive Pressure And at —40 Degrees F

Date of Test June 18, 1953 / June 19, 1953

Purpose of Test Strength of Zinc Ogive at excess pressure, and at −40°F.

PROJECTILE

Model T119E11
Type —
Weight 17.5 lbs. (Nominal)
C.G. Location —
Bourrelet Dia. —
Special Features Zinc Ogive DRC-558-1

TEST GUN

Model T137E3
Type 105mm Recoilless
Serial No 2
Chamber T137E3, #2
Bushing (Vent) 228-350-DA
Tube 228-370-P, 1 in 20 Twist
Sighting Equipment Telescope, Adapted M17
Mount
Type Pendulum
Constant 2.48 lb sec./in
Solenoid Mechanical Firing System

MISCELLANEOUS DATA

Range Recovery Box & Down Range
Propellant
Type M10 MP Web .0335 in. Weight Varies
Lot No PA 30239
Primer M57
Shell Case T53E1
Liner —
Temperatures
Magazine Max 70°F. Min 70°F. Present 70°F
Loading Room 75°F. Ambient 78° & 92°F.

* Piezo Gage ** Internal M3 (Cu).

Round No	Proj. No.	Proj. Weight (lb.)	Powder Charge (lb-oz)	Chamber Pressure* (lb/sq.in)	Chamber Pressure** (lb/sq in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Recoil (in)	Observations
			June 18, 1953	Excess Pressure test at ambient temperature					
5170	X726	17.53	7-12½	14,890	11,700	1696	1741	1 F	T119E11 with blunt nose fired to check pressure
5171	X725	17.54	7-12½	15,440	12,100	1681	1726	3 F	T119E11 with blunt nose fired to check pressure.
5172	X699	17.50	7-13	—	11,300	—	—	3¼ F	No evidence of zinc ogive failure on yaw cards or Fastax photographs. Poor recovery
5173	X697	17.51	7-13	—	12,300	1698	1743	2 F	No evidence of zinc ogive failure on yaw cards or Fastax photographs. Not recovered.
5174	X698	17.51	7-13½	14,905	10,900	1725	1770	4½ F	No evidence of zinc ogive failure on yaw cards, but first card shows spoiler disc separated. Poor recovery
5175	X701	17.52	7-13½	14,654	12,800	—	—	2 F	No evidence of zinc ogive failure on yaw cards. Poor recovery.
5176	X694	17.53	7-13½	14,888	11,000	—	—	3½ F	No evidence of zinc ogive failure on yaw cards. Poor recovery.
			June 19, 1953	Low temperature test at −40°F.					
5177	X695	17.52	7-13½	—	9,700	1645	1667	¾ R	Down range thru yaw cards. No evidence of zinc ogive failure on yaw cards. Apparent good flight.
5178	X693	17.55	7-13½	—	9800	1649	1671	5 R	Down range thru yaw cards. No evidence of zinc ogive failure on yaw cards. Apparent good flight
5179	X692	17.51	7-13½	—	9900	1645	1667	1½ R	Down range thru yaw cards. No evidence of zinc ogive failure on yaw cards. Apparent good flight.
5180	X696	17.53	7-13½	—	9,900	—	—	0	Fired into recovery box. No evidence of zinc ogive failure on yaw cards. Poor recovery.

Note: Fastax photographs were taken of projectile nos. X699, X697, X695, X693, X692, and X696.
Rounds 5172-5176 Nose cap replaced by aluminum spoiler disc (0.5 x 3.5 in. dia.).
Rounds 5177-5180 Standard nose cap on zinc ogive.

Proof Director E. Huffman
Observers F. Mendez, W. Hervey
Signed O. Miller

Table IV
Accuracy Range Data
T119E11 Projectile With Zinc Ogive

Date of Test June 23, 1953 / June 24, 1953

Purpose of Test Accuracy with Zinc Ogive

PROJECTILE
Model T119E11
Type ——
Weight 17.5 lbs. (Nominal)
C.G. Location ——
Bourrelet Dia ——
Special Features Zinc Ogive DRC-558-1

TEST GUN
Model T137E3
Type 105mm Recoilless
Serial No 28
Chamber 23-C-120-L
Bushing (Vent) 22-C-209-D
Tube 22-C-444-D
Sighting Equipment Elbow Telescope M62E4, #18006, Mount T183, # 8, & Gunners Quadrant, M1, #78261
Mount Type T152E4 Concrete Base

MISCELLANEOUS DATA
Range 1055 & 998 yds.
Propellant
Type M10 MP Web .0335 in Weight 7 lbs. 13 oz
Lot No PA 30239
Primer M57
Shell Case T53E1
Liner DRC-479-1
Temperatures
Magazine Max 70°F Min 70°F Present 70°F
Loading Room 72°F Ambient 74°F

* Internal M3(Cu)

Round No.	Proj. No.	Proj. Weight (lb.)	Powder Charge (lb-oz)	Wind Vel & Dir (b) mph degrees	Chamber Pressure* (lb/sq in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Azim (mils)	Elevation (mils) zero	Elevation (mils) super	Position of Hit (c) (inches) Vert	Position of Hit (c) (inches) Horiz	Corrected Position of Hit — mils (d) Vert	Corrected Position of Hit — mils (d) Horiz	Recoil (in)	Observations
June 23, 1953 - 1055 yds. - Line of fire 38° East of Magnetic North																
5156 - 1	X439(a)	17.53	—	5 - 33°	10,500/10,600	—	—	0	4.2	24.0	+ 9	- 39	—	—	—	
5157 - 2	X430(a)	17.52	—	7 - 45°	9200/—	1608	1643	0	4.4	24.0	- 9	-71 1/2	—	—	—	
5158 - 3	X686	17.54	—	8 1/2 - 50°	10,200/10,400	—	—	+36	—	24.0	+64 1/2	-16 1/2	—	—	—	
5159 - 4	X691	17.54	—	11 - 75°	10,800/10,600	1649	1684	+36	—	24.0	+22 1/2	- 4 1/2	—	—	—	
5160 - 5	X690	1754	—	5 - 55°	10,800/11,000	—	—	+36	—	24.0	—	—	—	—	—	Hit velocity coil and target frame.
June 24, 1953 - 998 yds - Line of fire 28° East of Magnetic North																Fin Diameter (in)
5161 - 6	X438(a)	17.55	—	13 - 85	10,000/10,600	1676	1699	+36	5.3	23.5	+ 59	- 80 1/2	—	—	—	
5162 - 7	X426(a)	17.52	—	5 - 90	—/10,000	1671	1694	+ 72	5.3	23.5	+ 39 1/2	+ 19	—	—	—	— — —
5163 - 8	X685	17.52	—	15 - 85	10,200/9,800	1699	1722	+ 72	—	23.5	+ 34	+ 50	+0.946	-0.608	—	10 1/2 — —
5164 - 9	X687	17.52	—	15 - 80	10,000/9,600	1630	1653	+ 72	—	23.5	+ 37 1/2	+ 56	+1.044	-0.441	—	11 — —
5165 - 10	X683	17.52	—	12 - 70	10,600/9,800	1657	1680	+ 72	—	23.5	+ 92 1/2	+ 50 1/2	+2.574	-0.594	—	10 1/2 x 10 1/2 x 10 1/2
5166 - 11	X688	17.52	—	14 - 83	10,200/10,600	—	—	+ 72	—	23.5	+ 64 1/4	+ 7	+1.788	-1.804	—	11 1/2 x 11 1/2 x 11 1/2
5167 - 12	X689	17.54	—	15 - 80	10,000/10,000	1700	1723	+ 72	—	23.5	+ 46 1/2	+ 73 1/2	+1.294	+0.046	—	10 1/4 x 11 1/2 x 11 1/2
5168 - 13	X684	17.52	—	15 - 85	10,400/10,200	1705	1728	+ 72	—	23.5	+ 24 1/2	+ 73 1/2	+0.682	+0.046	—	10 1/2 x 10 1/2 x 10 1/2
5169 - 14	X682	17.52	—	13 - 90	10,200/10,200	1702	1725	+ 72	5.3	23.5	+ 68	+ 73	+1.892	+0.032	—	11 1/4 x 10 1/2 x 10 1/2

(a) Standard T119E11 used for laying on target.
(b) Clockwise from magnetic North.
(c) Aiming and measuring reference point - center of target.
(d) Position of hits corrected to 23.5 mils elevation and zero azimuth.

Center of Impact Vert. = +1.46 mils; Horiz. = -.48 mils
Probable Error — Vertical ± .44 mils
Probable Error — Horizontal ± .44 mils
Rounds 5163 thru 5169

Proof Director J Chaney   Signed O. Miller

CONFIDENTIAL

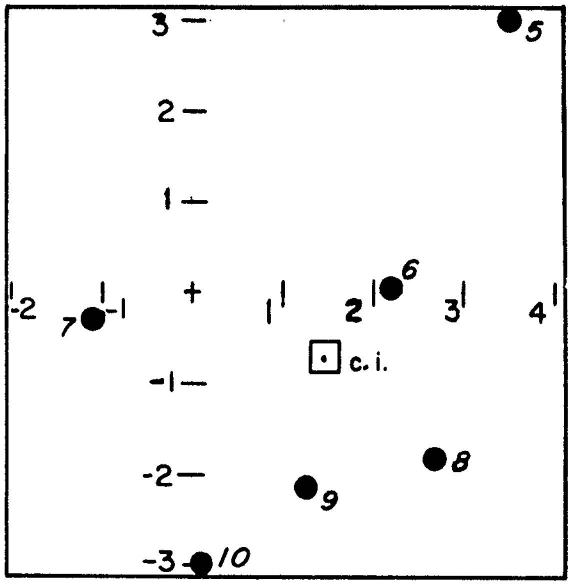
T171 PROJECTILE

Three modifications of the T171 projectile were fired for accuracy and stability evaluation at Erie Ordnance Depot at an 18 ft by 18 ft target placed 1000 yards from the gun muzzle. Ten projectiles each of MD3 and MD5, and twelve of MD11 were fired from a T137E2 rifle equipped with a 1-20 rifled tube. The projectiles did not have rotating bands. From spin measurements previously made it is estimated that the projectiles were rotating 2-3 rps when leaving the tube.

T171MD3 Projectile

Four of the ten rounds fired of this modification, Fig. 21, were used to develop a charge. The remaining six rounds hit the target, the probable errors of dispersion being V.P.E. = ± 1.45 mils and H.P.E. =±1.15 mils. In general, the rounds flew well but had a large yaw. Rounds 5 and 7 were particularly erratic. Fig. 22 is a dispersion chart of the firing and Table V is a copy of the firing record.

Although the T171MD3 projectile is statically and dynamically stable the stability is marginal and the drag coefficient is high. For these reasons and since other modifications are more promising the T171MD3 will not be tested further.



Probable Error H=±1.15, V=±1.45
Center of Impact H=1.44, V=-.71

Fig. 22. Dispersion Chart.
T171MD3 Modification, 1000 Yards.

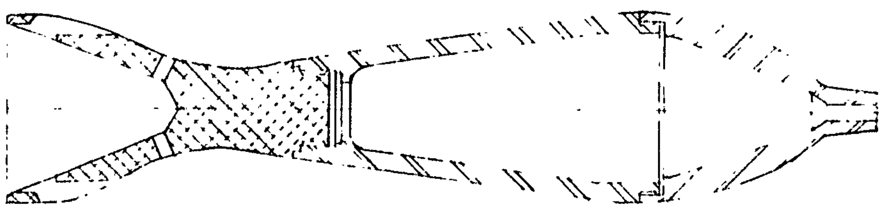


Fig. 21. T171MD3 Projectile.

T171MD5 Projectile

Nine of the ten rounds fired of this modification, Fig. 23, hit the target, round 8 being deflected by a velocity coil. The probable errors of dispersion for the nine rounds were V.P.E.=±.50 mil and H.P.E.=±.49 mil. Fig. 24 is a dispersion chart of the target and Table VI is a copy of the firing record.

All nine rounds appeared to fly well with very little yaw. The retardation factor for this projectile is .321 ft/sec/ft as compared with .386 ft/sec/ft for the T171MD3. The German wind tunnel data had indicated the drag force coefficient of these two types (MD3 and MD5) to be approximately the same. It is likely that the smaller yaw of the MD5 type is responsible for the smaller retardation factor. Although the dispersion is acceptable and the stability satisfactory, no further tests with this round are planned because of the high drag coefficient.

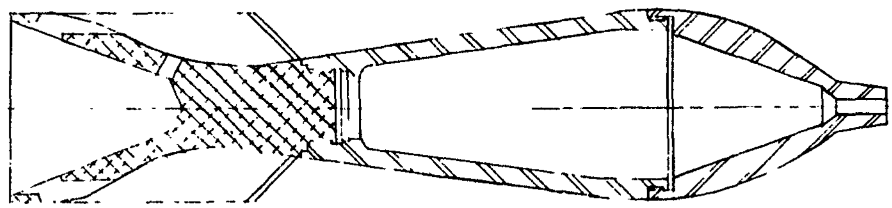
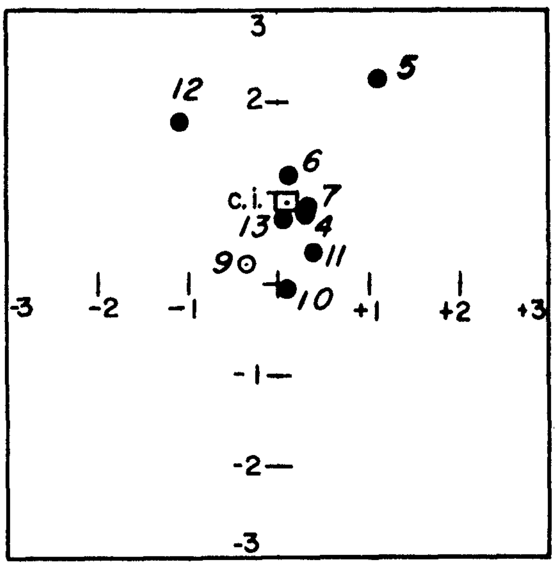


Fig. 23. T171MD5 Projectile.



Probable Error H=±.49, V=±.50
Center of Impact H=+.17, V=+.89

Fig. 24. Dispersion Chart.
T171MD5 Modification, 1000 Yards.

T171MD11 Projectile

Eleven of the twelve T171MD11 projectiles, Fig. 25, hit the target. Round 9 hit short because of a sighting error. Fig. 26 is a dispersion chart of the target hits. With the exception of round 10 the impact points cluster closely about the center of impact. The lower impact point for round 10 is consistent with the lower muzzle velocity. The probable errors of dispersion were — V.P.E.=±.53 mil

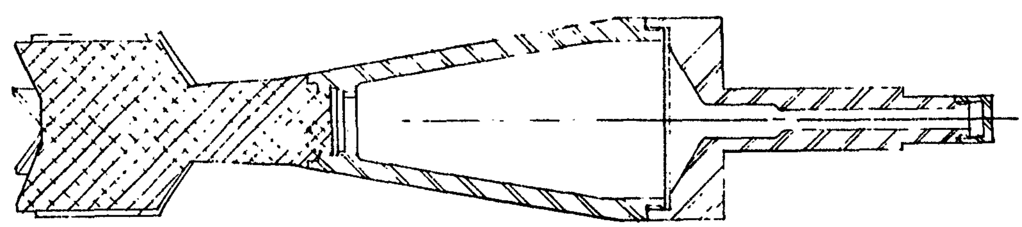
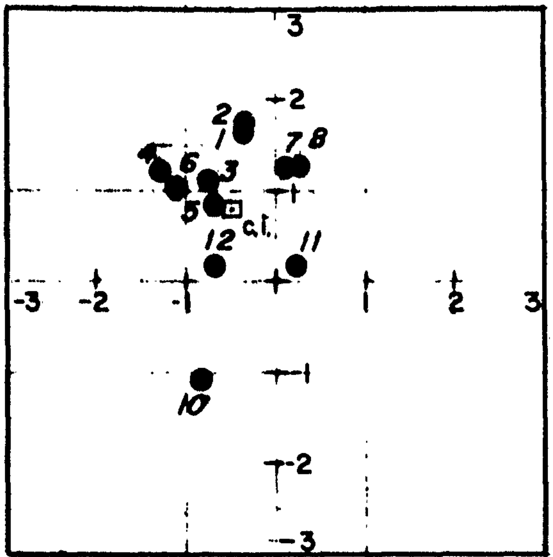


Fig. 25. T171MD11 Projectile.



Probable Error H=±.31, V=±.53
Center of Impact H=-.50, V=+.83

Fig. 26. Dispersion Chart.
T171MD11 Modification, 1000 Yards.

and H.P.E.=±.31 mil. If round 10 is omitted from the calculations the probable errors become V.P.E.=±.34 mil and H.P.E.=±.37 mil. Table VII is a copy of the firing record.

All of the twelve rounds flew well with very small yaw and it appears this round is sufficiently stable for acceptable performance at low spin rates. The retardation factor of .201 ft/sec/ft indicates the drag force coefficient is less than for either of the other modifications tested and less than that of the T138E57A projectile.

Future Program

Flight and accuracy tests are planned for the following projectile modifications:

1. T171MD11 modification

2. T171MD10 modification (See pages 17 and 18, Tables IX and X, Fourteenth Progress Report).

3. T171MD11 modification with the tee replaced by a T138E23M nose (page 19, BRL Memo Report 592, A. S. Platou).

Table V
Accuracy Range Data
T171MD3 Projectile

Gun —62'8"— 1 —106'4"— 2 —39'4"— 3 —27'3"— 4

Screen Distances

PROJECTILE

Model T171

Type MD3

Weight 17.45 lbs. (Nom.)

C.G. Location —

Bourrelet Dia 4.132 -.002 in.

Retardation Factor .39 ft/sec/ft

TEST GUN

Model T137E2

Type 105mm Recoilless

Serial No —

Chamber 1-K-679

Bushing (Vent) —

Tube 22-B-849-C, 1 in 20 Twist

Sighting Equipment Elbow Telescope, M62E4

Mount

Type T152E5

Serial #1

Purpose of Test To determine Accuracy & Stability of T171

Date July 10, 1953

MISCELLANEOUS DATA

Range 1000 yds. Accuracy

Propellant

Type M10 MP Web .0335 in. Weight Varies

Lot No. PA 30239

Primer T81

Shell Case T53

Liner Polyethylene

Temperatures

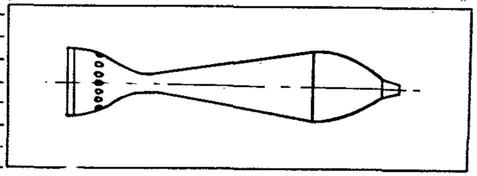
Magazine

Max. 70°F. Min 70°F. Present 70°F.

Loading Room 68°F. Ambient 71°F.

Round No	Time of Flight	Projectile No.	Projectile Wgt. (lb.)	Powder Charge lb.-oz	Wind Vel. & Dir. mph-degrees	Chamber Pressure (lb/sq.in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Azim (mils)	Elevation (mils) zero	Elevation (mils) super	Position of Hit (inches) Vert	Position of Hit (inches) Horiz.	Corrected Position of Hit — mils Vert	Corrected Position of Hit — mils Horiz	Yaw Max. Dia. (in.)	Observations
5254-1	—	19	17.53	7-13	13 — 340	7400 6800	1495	1540	0	4.8	29	—	—	—	—	—	Hit dirt in front of target, left of center.
5255-2	—	119	17.44	7-13	7 — 320	7800 6800	1498	1543	0	4.8	29	—	—	—	—	—	Hit dirt in front of target.
5256-3	—	115	17.44	8-1	6 — 035	7200 7500	1540	1585	0	4.8	29	—	—	—	—	—	Hit low, right of center
5257-4	—	118	17.46	8-3	6 — 000	6900 8000	1596	1641	0	4.8	29	-51½	+28	-1.934	+0.780	7	
5258-5	—	114	17.42	8-5	7 — 030	8500 8100	1614	1659	0	4.8	28.5	+108	+126	+3.007	+3.508	—	Swerved to right after hitting top of target.
5259-6	2.54762	117	17.44	8-5	7 — 000	8000 8300	1615	1660	0	4.8	28.5	+1	+79	+0.029	+2.199	6 7/8	
5260-7	2.57419	113	17.43	8-5	6 — 345	8000 8800	1603	1648	0	4.8	28.5	-11	-40	-0.306	-1.114	8 ½	Very erratic flight.
5261-8	2.53028	112	17.45	8-5	6 — 025	7300 7900	1618	1663	0	4.8	28.5	-67	+97	-1.865	+2.700	6 ½	
5262-9	2.55306	17	17.46	8-5	8 — 000	8300 7800	1600	1645	0	4.8	28.5	-77	+44½	-2.144	+1.239	4 ¾	
5263-10	—	18	17.44	8-5	6 — 015	8700 9000	1605	1650	0	4.8	28.5	-108	+5	-3.007	+0.139	—	

Note: The projectile was inserted into the tube to a distance where the lip of the case would barely touch it, then the case was inserted.



Center of Impact Vert. —0.713 mils; Horiz. = +1.442 mils
Probable Error — Vertical ± 1.45 ± .45 mils
Probable Error — Horizontal ± 1.15 ± .33 mils
} Rounds 5258-5263

Proof Director J. Chaney
Observers Dr. Ford, W.O. Davies

Signed P. Dacko, O. Miller

Table VI
Accuracy Range Data
T171MD5 Projectile

Gun — 62'8" — 1 — 106' 3" — 2 — 39' 3" — 3 — 27'4" — 4

Screen Distances

Purpose of Test Accuracy at 1000 yds
Date July 13, 1953

PROJECTILE

Model T171
Type MD5
Weight 17.40 lbs. (Nom)
Retardation Factor 0.321 ft/sec/ft
Bourrelet Dia 4.132 $^{-.002}$ in.
Special Features Rotating Band cut down to bourrelet diameter

TEST GUN

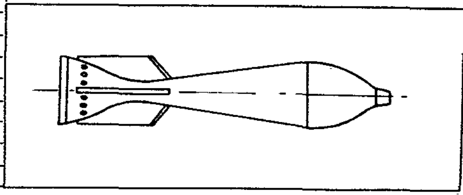
Model T137E2
Type 105 mm Recoilless
Serial No 2
Chamber 6-B-637
Bushing (Vent) 22-B-269-B-E
Tube 22-B-849-C, 1 in 20
Sighting Equipment Elbow Telescope M62E4, Tel Mount T183, #9, & Gunners Quadrant, M1, #113243
Mount
Type T152E5
Serial #1
Solenoid Mechanical Firing System

MISCELLANEOUS DATA

Range 1000 yds. Line of fire - 28° East of Magnet North.
Propellant
Type M10 MP Web .0335 in. Weight Varies
Lot No PA 30239
Primer T81
Shell Case T52
Liner Polyethylene
Temperatures
Magazine
Max 70°F. Min 70°F. Present 70°F.
Loading Room 68°F. Ambient 70°F.

Round No		Time of Flight	Projectile No.	Projectile Wgt (lb)	Powder Charge (lb.-oz)	Wind Vel & Dir(a) mph degrees	Chamber Pressure* (lb/sq in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Azim (mils)	Elevation (mils) zero	Elevation (mils) super	Position of Hit (inches) Vert	Position of Hit (inches) Horiz	Corrected Position of Hit — mils (b) Vert	Corrected Position of Hit — mils (b) Horiz	Recoil (in)	Observations
5264	1	—	—	—	8-7	5 - 030	12100 11200	1715	1760	-	4.8	-	—	—	—	—	3 1/4 R.	DRC 510 to check recoil. Pendulum Mount.
5265	2	—	—	—	8-5	6 - 045	16600 10300	1676	1721	-	4.8	-	—	—	—	—	1 1/2 R.	DRC 510 to check recoil. Pendulum Mount
5266	3	—	—	—	8-3	6 - 030	9400 —	1649	1694	-	4.8	-	—	—	—	—	1 R	DRC 510 to check recoil. Pendulum Mount
5267	4	—	137	17.40	8-7	7 - 040	7400 9300	1668	1705	0	-	28.5	+ 45	+ 11	+0.750	+0.306	—	Apparent good flight
5268	5	—	136	1740	8-5	10 - 045	8300 8700	1686	1723	0	-	28.5	+ 99	+ 58	+2.250	+1.161	—	Apparent good flight
5269	6	—	133	17.40	8-3	8 - 055	8800 9600	1638	1709	0	-	28	+ 43	+ 4 1/2	+1.197	+0.125	—	Apparent good flight
5270	7	2.56552	132	17.40	8-7	9 - 030	9000 9100	1666	1703	0	-	28	+ 29 1/2	+ 13	+0.821	+0.362	—	Apparent good flight
5271	8	—	140	17.40	8-7	11 - 045	9100 9200	1668	1705	0	-	28	—	—	—	—	—	Yawed, missed target
5272	9	2.40693	138	1738	8-7	9 - 045	8100 8700	1631	1702	0	-	28	+ 7 1/2	- 14	+0.209	-0.390	—	Apparent good flight
5273	10	—	131	17.38	8-7	7 - 060	9000 8700	1623	1694	0	-	28	- 3	+ 5 1/2	-0.084	+0.153	—	Apparent good flight
5274	11	3.05954	135	1740	8-7	10 - 035	6400 8700	1621	1692	0	-	28	+ 13 1/2	+ 14 1/2	+0.376	+0.404	—	Apparent good flight
5275	12	—	139	1740	8-7	8 - 060	10000 9800	1640	1711	0	-	28	+ 64	- 40	+1.782	-1.113	—	Apparent good flight
5276	13	2.54789	134	17.38	8-7	8.5 - 050	9300 8900	1634	1705	0	-	28	+ 24 1/2	+ 2 1/2	+0.682	+0.070	—	Apparent good flight

Note: Projectile & Propellant loaded separate. Average muzzle velocity of rounds 5267-5276 = 1705 ft/sec
(a) Degrees East of Magnetic North. (b) Corrected to 28 mils Elevation & 0 mils Azimuth
* Average M3 Internal Chamber Pressure = 8800 lbs/sq in



Center of Impact Vertical = +.886 mils, Horiz +0.170 mils
Probable Error — Vertical = ±0.499 ± .118 mils
Probable Error — Horizontal = ±0.486 ± .115 mils
} Rounds 5267-5270, 5272-5276.

Proof Director J. Chaney
Observers W. Davies
L. Sweebly

Signed Paul J. Dacko

Table VII
Accuracy Range Data
T171MD11 Projectile

Gun — 62'8" — 1 — 106'1" — 2 — 39'4" — 3 — 27'3" — 4

Screen Distances

PROJECTILE
Model T171
Type MD11
Weight 17.50 lbs. (Nom.)
C.G. Location
Bourrelet Dia. 4.132 $^{-.002}$ in.
Retardation Factor 0.201 ft./sec./ft

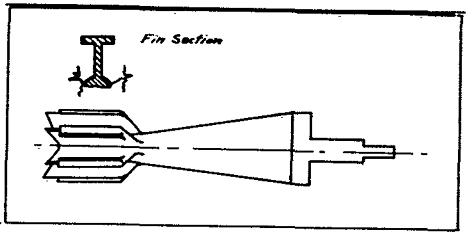
Purpose of Test Accuracy at 1000 yds.
Date July 14, 1953

TEST GUN
Model T137E2
Type 105 mm. Recoilless
Serial No 2
Chamber 6-8-637
Bushing (Vent) 22-8-269-8-E
Tube 22-8-849-C, 1 in 20 Twist
Sighting Equipment Elbow Telescope M62E4, Mount T183, #9, & Gunners Quadrant
Mount
Type T152E5
Serial 1
Solenoid Mechanical Firing System

MISCELLANEOUS DATA
Range 1000 yds. Line of fire 28° East of Magnetic N.
Propellant
Type M10 MP Web .0335 in. Weight 8 lb. 7 oz. ※※
Lot No. PA 38239
Primer T81
Shell Case T52
Liner Polyethylene
Temperatures
Magazine
Max. 74°F. Min. 68°F. Present 70°F.
Loading Room 68°F. Ambient 85°F.

※ Round No.	Time of Flight	Projectile No.	Projectile Weight (lbs)	Wind † Vel. & Dir.	Chamber Pressure †† (lb/sq.in.)	Muzzle Velocity ft/sec xx Instr	Muzzle Velocity Actual	Azim. (mils)	Elevation (mils) zero–super	Position of Hit (inches) Vert	Position of Hit Horiz.	Corrected Position of Hit — mils Vert.	Corrected Position Horiz.	Observations
5277-1	—	142	17.46	3 - 230	8900 6900	1659	1682	0	4.8 - 25	+56 1/2	-12 1/2	+1.569	-0.348	Apparent good flight.
5278-2	—	150	17.48	2 - 180	9100 8500	1667	1690	0	- 25	+ 61	- 13	+1.694	-0.362	Apparent good flight.
5279-3	2.26787	149	17.48	1.5 - 085	7400 8900	1664	1687	0	- 25	+ 38 1/2	-27 1/2	+1.072	-0.766	Apparent good flight.
5280-4	—	146	17.46	5.5 - 090	8900 8800	x1608	1653	0	- 25	+ 43 1/2	- 47	+1.208	-1.308	Apparent good flight.
5281-5	2.21225	152	17.46	4 - 060	9400 9200	1647	1692	0	- 25	+ 29 1/2	- 25	+0.821	-0.696	1/4 in. fin mark on target. Apparent good flight.
5282-6	2.20882	141	17.47	4 - 055	9500 9000	1672	1695	0	- 25	+ 36	- 41	+1.002	-1.141	1/4 in. fin mark on target. Apparent good flight.
5283-7	2.24193	147	17.47	7.5 - 030	—	1653	1676	0	- 25	+ 44	+ 2 1/2	+1.225	+0.070	Apparent good flight.
5284-8	2.24926	148	17.46	5 - 060	No	1651	1674	0	- 25	+ 44	+ 8 1/2	+1.225	+0.237	Apparent good flight.
5285-9	—	144	17.47	-	Gages	—	—	0	- 23	—	—	—	—	Apparent good flight.
5286-10	—	143	17.47	5 - 020	Used	1626	1649	0	- 25	- 37	- 29	-1.030	-0.807	Hit in front of target. Apparent good flight.
5287-11	2.32523	145	17.46	6 - 035	8600 9200	1655	1678	0	- 25	+ 6 1/2	+ 10	+0.181	+0.278	3/8 in. fin mark on target. Apparent good flight.
5288-12	2.63659	151	17.44	6 - 030	8400 8800	1654	1677	0	- 25	+ 7 1/2	- 22 1/2	+0.209	-0.626	1/4 in. fin mark on target. Apparent good flight.

Note: ※ Round 9 (5285) was gunners error, sighting was 2 mils lower than round 8. All rounds loaded & fired in two units.
Fastax pictures taken of round 1 (5277). Time of flights record from interval timer no. 4.
※※ Powder used for rounds 4-12 was not stored in constant temperature magazine.
† Degrees East of Magnetic North. †† Internal M3 Gage, Avg Actual = 8700 lb./sq. in.
x Under instrumental velocity taken between Coils 3 & 4. xx Avg. Muzzle Velocity = 1678 ft./sec.



Center of Impact Horiz. = -0.496; Vert. = +0.833
Probable Error — Vertical ±0.526 ±.112 mils
Probable Error — Horizontal ±0.314 ±.067 mils
} Rounds 5277-5284, 5286-5288.

Proof Director J. Chaney
Observers W. O. Davies, L. Swoebly

Signed Paul J. Dacko

CONFIDENTIAL

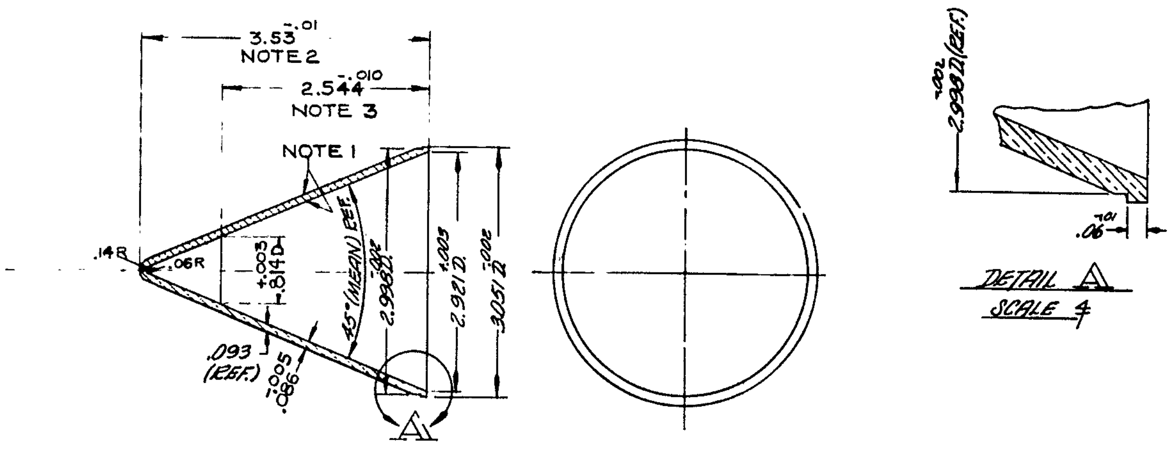
Scaling Studies

Two separate but related scaling studies have been planned. One series is based upon the DRB398 copper cone and the first part of this study was presented in the Thirty-Fifth Progress Report. The second series is based upon sharp apex cones. The results of this last study are presented in the following pages.

Scaling studies have as their primary purpose the extension of knowledge gained on the behavior of one size of cones to other sizes so that the studies do not all have to be repeated for every different caliber of projectile. The cones used in this study were all machined from copper bar and are 45-degree cones with a sharp, or simple, apex and were scaled in accordance with charge diameters of 2.5 (DRB666), 3.0 (DRB667) and 3.5 (DRB 681) inches. Fig. 27 shows the 3.0-inch DRB667 cone. The flange thickness, tolerances and apex radii were held constant for all cones but the wall thickness and base register diameter were scaled.

The cones were assembled in test assemblies similar to, but appropriately scaled from, the DRC376 test assembly. Fig. 28 shows a typical assembly. The diameter, length, and wall confinement of the test bodies were all scaled in the ratios of the cone diameters 2.5/3.0/3.5.

The inspection data for the three series of cones are shown in Tables VIII, IX and X. In each case the average wall thickness is slightly less than the specifications state, but the wall thickness ratios are scaled within 2% of the proper proportion.



NOTE:
1 ALL INDICATED SURFACES TO BE CONCENTRIC WITHIN .003 T.I.R WITH RESPECT TO 2.998 DIA. REGISTER.
2 ALL INDICATED SURFACES TO BE FLAT & PARALLEL TO WITHIN .005 T.I.R & PERPENDICULAR TO ¢ OF PART.
3 IN THIS REGION VARIATION IN STRAIGHTNESS OR THICKNESS OF WALL SHALL NOT EXCEED .003 IN ANY AXIAL PLANE; WALL THICKNESS IN ANY TRANSVERSE PLANE SHALL NOT EXCEED .001 VARIATION.
4 FINISH 63

Fig. 27. DRB667 Sharp Apex Cone.
3.0-inch Charge Diameter.

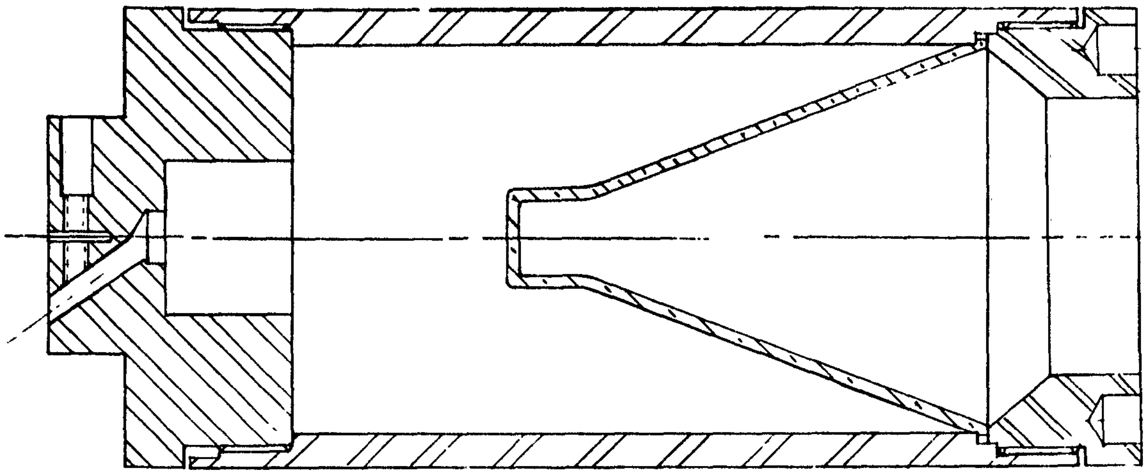


Fig. 28. Typical Penetration Test Assembly.
DRB666 (2.5-inch), DRB667 (3.0-inch) or DRB681 (3.5-inch) Cones.

Scaling of Standoff

The penetration data for the effect of standoff are presented in Tables XI to XIII and are plotted in Fig. 29. The curves are of the same general shape and disclose nothing unusual other than the unexpectedly poor showing of the 2.5-inch charges at long standoff (25 inches). Fig. 30 is a generalized plot showing the effect of standoff. Both depth of penetration and standoff are expressed in terms of

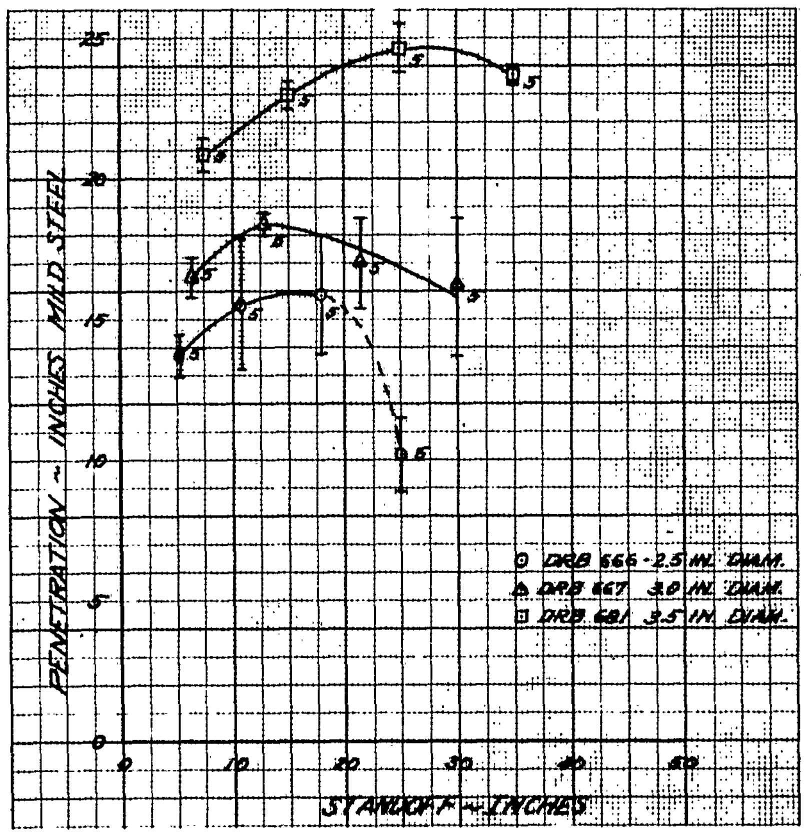


Fig. 29. Penetration Versus Standoff.
DRB666 (2.5-inch), DRB667 (3.0-inch), DRB681 (3.5-inch) Cones.

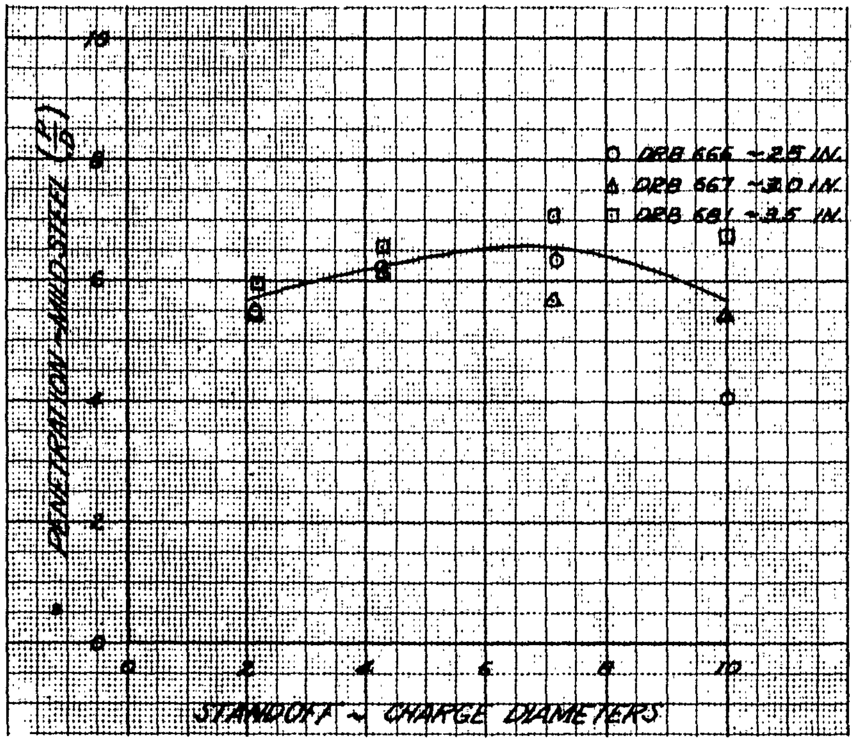


Fig. 30. Effect of Standoff on Penetration.
Expressed In Terms of Charge Diameters.

charge diameters. Penetration theory predicts that a single curve should adequately represent the data for these three series of cones. This is seen to be approximately correct for standoff distances up to 4 or 5 charge diameters. At the longer standoff distances other factors such as precision of manufacture, charge symmetry, etc., become increasingly important and the penetration data become less reproducible and reliable. It is noteworthy that the curve of Fig. 30 is in excellent agreement with the similar type of plot for 2.5-inch and 3.5-inch diameter DRB398 type cones reported in the Thirty-Fifth Progress Report.

Scaling of the Rotational Effect

The penetration data for the effect of rotation are presented in Tables XIV to XVI and are plotted in Fig. 31. The data for a 1.63-inch diameter charge, also shown in the plot, are for a rather similar cone and charge, (not scaled directly) whose performance was reported by Carnegie Institute of Technology in report CIT-ORD-R18). These curves emphasize the very great effect of rotation upon penetration performance and demonstrates the futility of attempting to obtain substantial increases in the penetration of rotating rounds by simply increasing the size of the charge.

Fig. 32 is a generalized plot in terms of the "reduced" penetration and spin rate. The reduced penetration may be defined as the observed penetration at the spin rate ω divided by the non-rotated penetration. The reduced spin rate is the spin rate expressed in terms of the relative linear surface velocity of the cone base - ωD. As expected the effect of spin is invariant under these transformations and the one curve represents the data for all of the charges quite well. The general applicability of this curve is demonstrated by the fact that the data shown in the Thirty-Fifth Progress Report (Fig. 11) for the DRB398 type cones are also quite adequately represented by the generalized curve shown in Fig. 32 of this report.

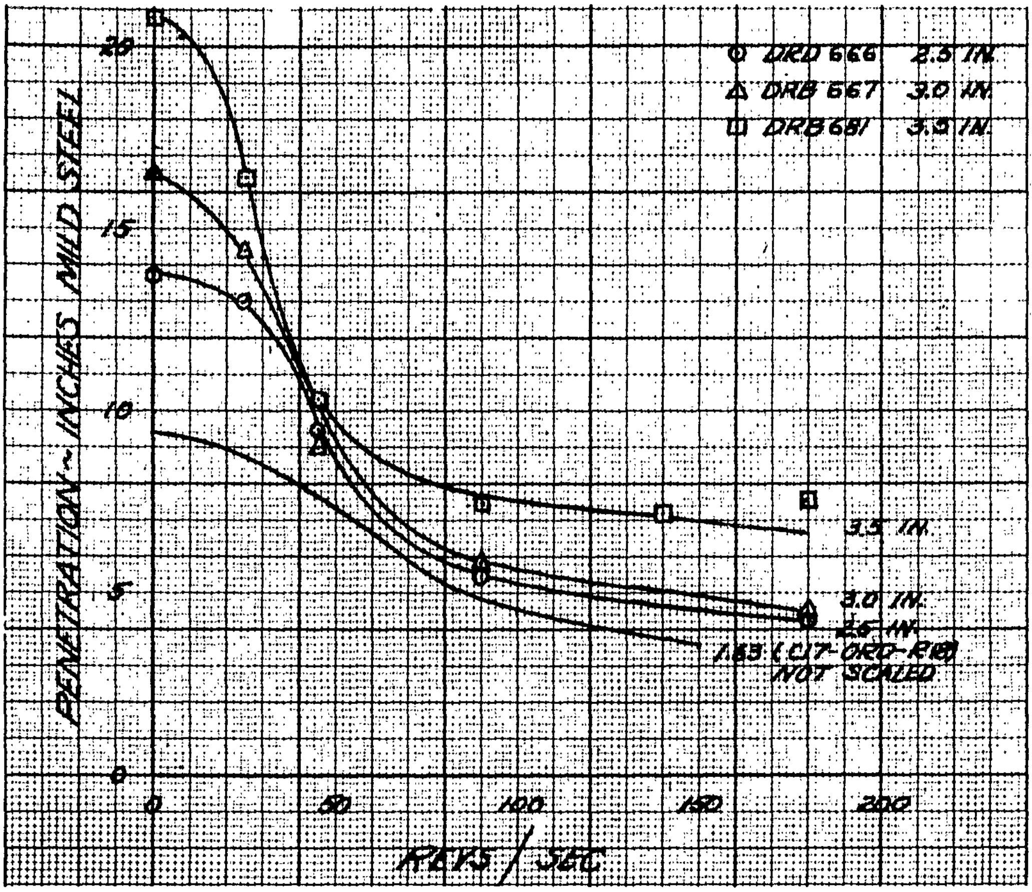


Fig. 31. Penetration Versus Rotation.
DRB666 (2.5-inch), DRB667 (3.0-inch), DRB681 (3.5-inch) Cones.

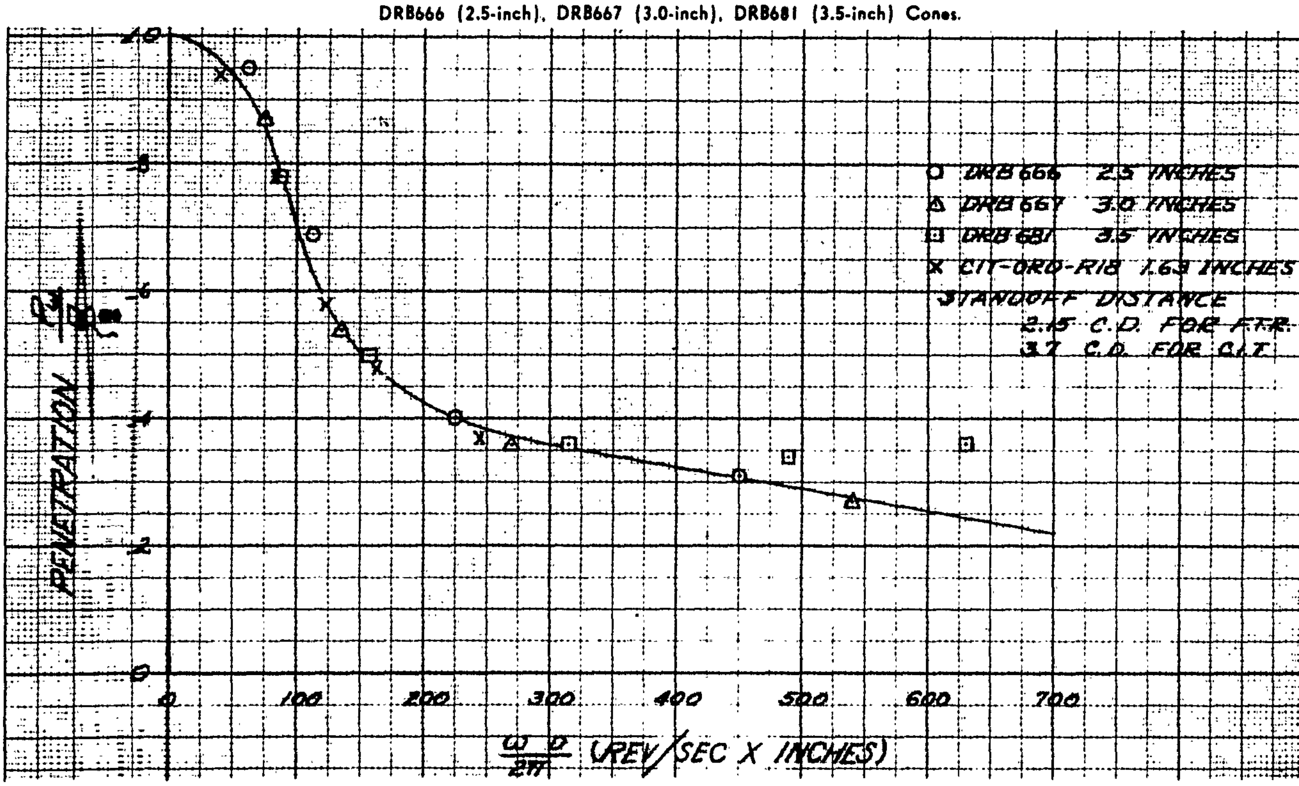


Fig. 32. Effect of Rotation On Penetration.
Expressed In Terms of "Reduced" Penetration and Spin Rate.

Table VIII
Inspection Data
DRB666 Sharp Apex Cones

Cone No.	Wall Thickness - inches			Max. Variation in Wall Thickness - in.		Max. Wall Waviness - inches		Concentricity — T.I.R.		
	Max.	Min.	Avg.	Transv.	Long.	O.D.	I.D.	Base Datum	Apex Datum	Cone Tip in Assembly
Specification DRB666	.071	.066		.001	.003	.003	.003	.0030	.0030	.015 (Nominal)
R101	.068	.066	.0670	<.001	.002	.001	.003	.0010	.0010	.007
R102	.070	.068	.0689	.001	.002	.001	.005	.0010	.0010	.004
R103	.069	.067	.0681	.001	.002	.001	.003	.0010	.0010	.003
R104	.070	.068	.0692	.001	.002	<.001	.002	<.0010	.0010	.004
R105	.069	.068	.0685	<.001	.001	.001	.002	<.0010	<.0010	.006
R106	.069	.067	.0680	<.001	.002	.001	.003	.0010	<.0010	.002
R107	.069	.066	.0672	.001	.003	.001	.003	.0010	<.0010	.010
R108	.068	.067	.0675	.001	.001	.001	.002	.0010	.0010	.003
R109	.068	.066	.0673	.001	.002	.001	.003	.0010	.0010	.002
R110	.069	.067	.0684	.001	.002	.001	.002	.0010	<.0010	.004
R111	.069	.067	.0685	.001	.002	.001	.003	<.0010	<.0010	.005
R112	.069	.068	.0687	.001	.001	.001	.002	<.0010	<.0010	.013
R113	.068	.067	.0676	.001	.001	.001	.003	<.0010	<.0010	.001
R114	.068	.066	.0674	.001	.002	.001	.002	<.0010	<.0010	.002
R115	.068	.066	.0671	.001	.002	.001	.003	<.0010	<.0010	.006
R116	.068	.067	.0675	<.001	.001	.001	.003	<.0010	<.0010	.006
R117	.069	.068	.0685	<.001	.001	.001	.002	<.0010	.0010	.001
R118	.069	.069	.0690	<.001	.001	.001	.002	<.0010	<.0010	.006
R119	.069	.067	.0680	<.001	.002	.001	.002	<.0010	.0010	.002
R120	.069	.067	.0682	.001	.002	.001	.003	.0010	<.0010	.004
R121	.069	.066	.0680	.001	.002	.001	.002	.0010	<.0010	.009
R122	.069	.066	.0673	.001	.003	.001	.003	<.0010	.0010	.006
R123	.069	.067	.0680	<.001	.002	.001	.003	<.0010	<.0010	.001
R124	.069	.067	.0685	.001	.002	.001	.003	<.0010	<.0010	.001
R125	.068	.065	.0668	.001	.003	.001	.003	.0010	<.0010	.007
R126	.068	.066	.0671	.001	.002	.001	.003	<.0010	<.0010	.003
R127	.069	.067	.0682	.001	.002	.001	.002	.0010	.0010	.005
R128	.068	.066	.0671	.001	.002	.001	.003	<.0010	.0010	.004
R129	.069	.067	.0682	.001	.002	.001	.004	<.0010	<.0010	.013
R130	.069	.067	.0681	.001	.002	.002	.003	.0010	<.0010	.003
R131	.070	.067	.0685	.001	.002	.001	.003	.0010	<.0010	.007
R132	.070	.069	.0695	<.001	.001	.001	.003	<.0010	<.0010	.004
R133	.069	.065	.0670	.001	.003	.001	.004	.0010	<.0010	.005
R134	.068	.065	.0668	.001	.003	.001	.004	<.0010	.0010	.008
R135	.069	.067	.0680	<.001	.002	.001	.003	<.0010	<.0010	.001
R136	.069	.067	.0682	.001	.002	.001	.002	.0010	.0010	.004
R137	.069	.067	.0681	.001	.002	.001	.005	<.0010	<.0010	.006
R138	.070	.069	.0698	.001	.001	.001	.003	.0010	<.0010	.003
R139	.068	.067	.0676	.001	.001	.001	.003	<.0010	<.0010	.002
R140	.068	.067	.0676	.001	.001	.001	.001	.0010	<.0010	.003
Average	.0688	.0669	.0680	.0010	.0019	.0010	.0033	.0010	.0010	.0047
Std. Dev.	±.0006	±.0010	±.0008	----	±.0006	----	±.0008	----	----	±.0030

Notes:
1. The lower datum is .484 inch above base; the upper datum is 2.12 inches above base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter. The difference between the runout at the two datum planes is an indication of the lack of perpendicularity of the register plane and the liner's axis.

Table IX
Inspection Data
DRB667 Sharp Apex Cones

Cone No.	Wall Thickness (in.)			Maximum Variation in Wall Thickness (in.)		Max. Wall Waviness (in.)		Concentricity – T.I.R		
	Max.	Min.	Avg.	Transverse	Longitudinal	O.D.	I.D.	Base Datum[1]	Apex Datum	Cone Tip in Assembly
Specification DRB-667	.086	.081	--	.001	.003	.003	.003	.0030	.0030	.015(nom)
R141	.085	.084	.0845	<.001	.001	<.001	.002	<.0010	<.0010	.003
R142	.083	.083	.0830	<.001	<.001	<.001	.001	.0010	.0010	.010
R143	.083	.083	.0830	<.001	<.001	.001	.003	<.0010	<.0010	.004
R144	.083	.081	.0820	<.001	.002	.001	.002	<.0010	<.0010	.006
R145	.085	.083	.0848	.001	.002	<.001	.002	.0010	.0010	.013
R146	.085	.084	.0845	<.001	.001	<.001	.004	<.0010	<.0010	.005
R147	.083	.081	.0822	.001	.002	.001	.002	<.0010	<.0010	.005
R148	.085	.084	.0845	<.001	.001	.001	.003	<.0010	<.0010	.007
R149	.083	.081	.0822	.001	.002	<.001	.002	<.0010	<.0010	.005
R150	.084	.082	.0838	.001	.002	.001	.002	<.0010	.0010	.010
R151	.083	.081	.0821	.001	.002	<.001	.002	<.0010	<.0010	.008
R152	.084	.083	.0836	.001	.001	.001	.002	.0010	.0010	.012
R153	.083	.081	.0820	<.001	.002	.001	.003	<.0010	<.0010	.004
R154	.085	.084	.0849	.001	.001	<.001	.001	<.0010	<.0010	.022
R155	.083	.082	.0825	<.001	.001	.001	.002	<.0010	<.0010	.007
R156	.084	.081	.0825	.001	.003	.001	.003	<.0010	<.0010	.009
R157	.084	.082	.0830	<.001	.002	<.001	.003	<.0010	<.0010	.006
R158	.083	.081	.0821	.001	.002	<.001	.002	<.0010	<.0010	.007
R159	.084	.083	.0835	<.001	.001	.003	.002	.0010	.0060	.003
R160	.084	.081	.0826	.001	.003	<.001	.003	<.0010	.0010	.007
R161	.083	.081	.0829	.001	.003	<.001	.003	<.0010	<.0010	.006
R162	.084	.082	.0835	.002	.002	.002	.002	.0010	.0020	.004
R163	.081	.079	.0812	.001	.002	<.001	.002	<.0010	.0010	.006
R164	.083	.080	.0820	.001	.003	.001	.004	<.0010	<.0010	.006
R165	.084	.082	.0830	<.001	.002	<.001	.002	<.0010	<.0010	.010
R166	.085	.081	.0829	.001	.004	.001	.003	.0010	.0010	.004
R167	.083	.081	.0821	.001	.002	<.001	.002	.0010	.0010	.004
R168	.084	.079	.0818	.001	.005	<.001	.004	.0010	.0010	.004
R169	.084	.081	.0829	.001	.003	<.001	.003	<.0010	<.0010	.004
R170	.084	.081	.0825	<.001	.003	<.001	.003	<.0010	<.0010	.005
R171	.084	.083	.0834	.001	.001	<.001	.003	<.0010	<.0010	.004
R172	.083	.080	.0816	.001	.003	.002	.004	<.0010	<.0010	.005
R173	.083	.080	.0815	<.001	.003	.002	.005	<.0010	<.0010	.009
R174	.084	.082	.0836	.002	.002	<.001	.003	.0010	.0010	.005
R175	.084	.082	.0830	<.001	.002	<.001	.004	<.0010	<.0010	.009
R176	.084	.081	.0831	.002	.003	<.001	.004	<.0010	.0010	.007
R177	.084	.081	.0828	.001	.003	<.001	.003	<.0010	<.0010	.009
R178	.084	.082	.0834	.001	.002	.002	.003	<.0010	.0020	.015
R179	.084	.083	.0835	<.001	.001	<.001	.003	<.0010	<.0010	.015
R180	.084	.083	.0835	<.001	.001	.001	.003	.0010	.0010	.007
AVG. =	.0837	.0818	.0829	.0007	.0020	.0012	.0026	.0010	.0005	.0073
δ =	±.0008	±.0027	±.0009	±.0004	±.0010	±.0004	±.0009	---	±.0010	±.0038

Notes: The base datum is located .484 in. above the cone base; the apex datum 2.544 in. above the cone base.

Table X
Inspection Data
DRB681 Sharp Apex Cones

Cone No.	Wall Thickness (inches)			Max. Variation in Wall Thickness (in.)		Max. Wall Waviness (in.)		Concentricity – T.I.R.		
	Max.	Min.	Avg.	Transverse	Longitud.	O. D.	I. D.	Base Datum	Apex Datum	Cone Tip in Assembly
Specification DRB681	.100	.095		.001	.003	.003	.003	.0030	.0030	.015 Nominal
R181	.099	.097	.0971	.001	.002	.001	.001	.0020	.0020	.004
R182	.098	.097	.0975	<.001	.001	.001	.002	.0020	.0020	.013
R183	.098	.095	.0965	<.001	.003	.001	.005	.0020	.0030	.004
R184	.098	.097	.0975	<.001	.001	.001	.003	.0030	.0030	.005
R185	.099	.095	.0971	.001	.004	.002	.004	.0020	.0020	.003
R186	.098	.098	.0980	<.001	<.001	.001	.002	.0010	.0010	.002
R187	.099	.098	.0984	.001	.001	.001	.003	.0030	.0020	.005
R188	.098	.097	.0973	.001	.001	.001	.003	.0010	<.0010	.002
R189	.098	.097	.0978	.001	.001	<.001	.004	.0020	.0020	.010
R190	.098	.097	.0973	.001	.001	.001	.002	.0020	.0020	.006
R191	.099	.098	.0985	.001	.001	<.001	.003	.0020	.0020	.003
R192	.098	.098	.0980	<.001	<.001	.001	.003	.0020	.0030	.005
R193	.103	.099	.1005	.002	.004	.001	.006	.0030	.0030	.003
R194	.101	.098	.0995	.001	.002	<.001	.003	.0030	.0030	.003
R195	.100	.098	.0990	<.001	.002	.002	.004	.0010	<.0010	.003
R196	.099	.098	.0983	.001	.001	.001	.002	.0020	.0010	.002
R197	.098	.097	.0989	.001	.001	.001	.003	.0030	.0030	.004
R198	.099	.098	.0985	<.001	.001	.001	.002	.0020	.0020	.001
R199	.098	.096	.0963	.001	.002	.002	.003	.0010	<.0010	.002
R200	.098	.095	.0964	.001	.003	<.001	.003	.0010	.0010	.003
R201	.097	.096	.0965	<.001	.001	.001	.003	.0030	.0030	.008
R202	.098	.097	.0975	<.001	.001	<.001	.003	<.0010	<.0010	.002
R203	.098	.095	.0965	<.001	.003	<.001	.003	.0010	.0010	.004
R204	.098	.098	.0980	<.001	<.001	<.001	.002	.0020	.0010	.004
R205	.097	.096	.0978	.001	.001	.001	.001	.0010	.0010	.004
R206	.098	.097	.0978	.001	.001	.001	.002	.0010	.0010	.005
R207	.099	.098	.0985	<.001	.001	.001	.003	.0010	.0010	.003
R208	.098	.098	.0980	<.001	<.001	.001	.004	.0010	.0010	.003
R209	.098	.098	.0980	<.001	<.001	.001	.002	.0010	<.0010	.002
R210	.098	.098	.0980	<.001	<.001	.001	.003	.0020	.0010	.004
R211	.098	.097	.0963	.001	.001	<.001	.003	.0010	.0010	.009
R212	.099	.097	.0973	.001	.001	.001	.003	.0010	.0010	.006
R213	.098	.098	.0980	<.001	<.001	.001	.003	.0020	.0030	.003
R214	.099	.098	.0985	<.001	.001	.001	.003	.0030	.0020	.001
R215	.098	.095	.0969	.001	.003	.001	.004	.0010	<.0010	.003
R216	.097	.097	.0970	<.001	<.001	<.001	.001	.0010	<.0010	.006
R217	.101	.099	.0999	.001	.002	.001	.004	.0010	.0010	.007
R218	.099	.097	.0984	.001	.002	.001	.003	.0020	.0020	.003
R219	.099	.098	.0985	<.001	.001	.001	.003	.0010	.0020	.003
R220	.099	.098	.0985	<.001	.001	.002	.004	.0030	.0030	.004
Average	.0986	.0972	.0978	.0010	.0013	.0009	.0030	.0017	.0016	.0042
Std Dev.	±.0011	±.0011	±.0002	----	±.0010	±.0005	±.0010	±.0008	±.0010	±.0024

Notes:

1. Lower datum is .484 inch above base; upper datum is 2.968 inches above base.
2. The indicated measurement at each datum is the total indicator runout of the liners outside surface relative to the register diameter. The difference between the runout at the two datum planes is an indication of the lack of perpendicularity of the register plane and the liners axis.

Table XI
Penetration Data
DRB666 Sharp Apex Cones
Effect of Standoff

Round No	Comp B (lbs)	Standoff (inches)	Penetration (inches M.S.)	Max Spread (inches)	Std. Dev (inches)
R101	.94	5.4	14.31		
R102	.94	"	14.44		
R103	.94	"	13.75		
R104	.96	"	13.69		
R105	.96	"	12.56		
			Avg. 13.75	1.88	±.75
R106	.96	10.7	17.50		
R107	.94	"	13.38		
R108	.94	"	18.31		
R109	.96	"	13.31		
R110	.94	"	15.25		
			Avg. 15.55	5.00	±2.31
R111	.96	18.0	15.18		
R112	.94	"	18.00		
R113	.94	"	15.81		
R114	.96	"	12.69		
R115	.94	"	17.62		
			Avg. 15.86	5.31	±2.14
R136	.94	25.0	11.25		
R137	.94	"	11.18		
R138	.94	"	7.69		
R139	.94	"	10.69		
R140	.96	"	10.12		
			Avg. 10.19	3.56	±1.33

Notes:
1. Rounds assembled with DRC505-1 bodies, plugs and rings (No. 2).
2. Loaded at Ravenna Arsenal, BAT Lot No. 29, with Composition B from Holston Lot No. 4-1197.
3. Tested without rotation at Erie Ordnance Depot.

Table XII
Penetration Data
DRB667 Sharp Apex Cones
Effect of Standoff

Round No.	Comp B (lbs.)	Standoff (inches)	Penetration (inches M S.)	Max. Spread (inches)	Std Dev (inches)
R141	1.64	6.4	16.69		
R142	1.64	"	16.88		
R143	1.66	"	15.44		
R144	1.64	"	17.12		
R145	1.66	"	16.44		
			Avg. 16.51	1.68	±.66
R146	1.64	12.9	18.56		
R147	1.66	"	17.75		
R148	1.64	"	18.56		
R149	1.66	"	18.69		
R150	1.62	"	18.31		
			Avg. 18.37	0.94	±.38
R151	1.60	21.4	16.81		
R152	1.62	"	19.69		
R153	1.62	"	16.94		
R154	1.64	"	15.88		
R155	1.64	"	15.88		
			Avg. 17.04	3.81	±1.57
R176	1.64	30.0	19.94		
R177	1.62	"	16.62		
R178	1.64	"	13.81		
R179	1.58	"	13.88		
R180	1.60	"	17.00		
			Avg. 16.25	6.13	±2.55

Notes:
1. **Rounds assembled with DRC506-1 bodies, plugs and rings (No. 2).**
2. **Loaded at Ravenna Arsenal, BAT Lot No. 29, with Composition B from Holston Lot No. 4-1197.**
3. **Tested without rotation at Erie Ordnance Depot.**

Table XIII
Penetration Data
DRB681 Sharp Apex Cones
Effect of Standoff

Round No.	Comp B (lbs)	Standoff (inches)	Penetration (inches M S)	Max Spread (inches)	Std Dev (inches)
R181	2.54	7.5	21.12		
R182	2.56	"	21.69		
R183	2.56	"	20.31		
R184	2.56	"	20.18		
R185	2.56	"	20.88		
			Avg. 20.84	1.51	±.62
R186	2.54	15.0	23.69		
R187	2.56	"	22.62		
R188	2.56	"	23.25		
R189	2.54	"	22.56		
R190	2.52	"	23.00		
			Avg. 23.02	1.13	±.47
R191	2.54	25.0	25.00		
R192	2.54	"	23.44		
R193	2.56	"	24.25		
R194	2.54	"	25.69		
R195	2.54	"	24.88		
			Avg. 24.65	2.25	±.85
R216	2.58	35.0	23.69		
R217	2.54	"	23.31		
R218	2.54	"	24.18		
R219	2.54	"	23.88		
R220	2.56	"	23.50		
			Avg. 23.71	0.87	±.34

Notes:
1. Rounds assembled with DRC376 bodies, plugs and rings (No. 2).
2. Loaded at Ravenna Arsenal, BAT Lot No. 31, with Composition B from Holston Lot No. 4-1197.
3. Tested without rotation at Erie Ordnance Depot.

Table XIV
Penetration Data
DRB666 Sharp Apex Cones
Effect of Rotation

Round No.	Comp B (lbs)	Rev/Sec	Penetration (inches M.S.)	Max Spread (inches)	Std Dev. (inches)
R101	.94	0	14.31		
R102	.94	"	14.44		
R103	.94	"	13.75		
R104	.96	"	13.69		
R105	.96	"	12.56		
			Avg. 13.75	1.88	±.75
R116	.94	25	13.18		
R117	.96	"	13.62		
R118	.96	"	13.31		
R119	.96	"	12.56		
R120	.96	"	12.75		
			Avg. 13.08	1.06	±.41
R121	.94	45	10.12		
R122	.96	"	10.00		
R123	.96	"	9.25		
R124	.96	"	8.18		
R125	.96	"	10.00		
			Avg. 9.51	1.94	±.82
R126	.94	90	5.00		
R127	.96	"	5.38		
R128	.94	"	5.50		
R129	.94	"	5.38		
R130	.94	"	6.18		
			Avg. 5.49	1.18	±.43
R131	.94	180	3.88		
R132	.94	"	4.38		
R133	.96	"	4.12		
R134	.96	"	4.81		
R135	.94	"	4.38		
			Avg. 4.31	.93	±.34

Notes:
1. Rounds assembled with DRC505-1 bodies, plugs and rings (No. 2.)
2. Loaded at Ravenna Arsenal, BAT Lot No. 29, with Composition B from Holston Lot No. 4-1197.
3. Testea at Erie Ordnance Depot using a standoff of 5.4 inches.

Table XV
Penetration Data
DRB667 Sharp Apex Cone
Effect of Rotation

Round No	Comp B (lbs)	Rev./Sec	Penetration (inches M S)	Max Spread (inches)	Std Dev (inches)
R141	[illegible]		[illegible]		
R142	[illegible]		[illegible]		
R143	[illegible]		15.14		
R144	[illegible]		17.12		
R145	[illegible]		16.44		
			Avg. 16.51	1.68	±.66
R156	[illegible]	25	14.69		
R157	[illegible]		14.38		
R158	1.64		14.38		
R159	1.64		13.75		
R160	1.64		14.62		
			Avg. 14.36	.94	±.37
R161	[illegible]	15	9.12		
R162	1.62	"	9.12		
R163	1.66	"	7.88		
R164	1.64	"	9.12		
R165	1.66	"	9.62		
			Avg. 8.97	1.74	±.64
R166	1.64	90	6.31		
R167	1.64	"	6.18		
R168	1.62	"	5.69		
R169	1.64	"	6.00		
R170	1.62	"	5.38		
			Avg. 5.91	.93	±.38
R171	1.66	180	4.62		
R172	1.64	"	4.81		
R173	1.66	"	4.81		
R174	1.64		4.06		
R175	1.64		4.12		
			Avg. 4.48	.75	±.34

Notes:
1. Rounds assembled with DRC506-1 bodies, plugs and rings (No. 2).
2. Loaded at Ravenna Arsenal, BAT Lot No. 29, with Composition B from Holston Lot No. 4-1197.
3. Tested at 6.40 inch standoff at Erie Ordnance Depot.

Table XVI
Penetration Data
DRB681 Sharp Apex Cone
Effect of Rotation

Round No	Comp B (lbs.)	Rev/Sec	Penetration (inches M.S)	Max Spread (inches)	Std Dev (inches)
R181	2.54	0	21.12		
R182	2.56	"	21.69		
R183	2.56	"	20.31		
R184	2.56	"	20.18		
R185	2.56	"	20.88		
			Avg. 20.84	1.51	±.62
R196	2.58	25	16.31		
R197	2.56	"	15.62		
R198	2.56	"	16.94		
R199	2.54	"	15.94		
R200	2.56	"	17.06		
			Avg. 16.37	1.44	±.63
R201	2.58	45	9.25		
R202	2.54	"	10.75		
R203	2.56	"	11.18		
R204	2.58	"	10.31		
R205	2.56	"	10.18		
			Avg. 10.33	1.93	±.73
R206	2.54	90	7.56		
R207	2.56	"	7.06		
R208	2.56	"	7.12		
R209	2.56	"	7.06		
R210	2.52	"	8.38		
			Avg. 7.44	1.32	±.57
R213	2.56	140	8.00		
R214	2.54	"	7.25		
R215	2.56	"	6.31		
			Avg. 7.19	1.69	±.85
R211	2.54	180	7.88		
R212	2.54	"	7.25		
			Avg. 7.57	.63	--

Notes:
1. Rounds assembled with DRC376 bodies, plugs and rings (No. 2).
2. Loaded at Ravenna Arsenal, BAT Lot #31, with Composition B from Holston Lot No. 4-1197.
3. Tested at 7.5 inch standoff at Erie Ordnance Depot.

Future Program

1. Scaling Studies

One series of DRB398 type cone scaled in the ratio 90/105 remains to be tested. These data will complete this phase of the scaling studies. Additional studies with cones of another apex angle are being planned.

2. Cones Made of Zinc and Aluminum are to be tested for penetration. Penetrations approaching those of copper cones have been reported for certain aluminum and zinc alloys.

3. Composite Cone Study. A series of tests using copper cones with aluminum inserts will be tested.

a. .080-inch thick copper shell and .020 and .040-inch aluminum insert (24S-T4).

b. .100-inch thick copper shell and .020 and .040-inch aluminum insert (24S-T4).

c. Same as (a) and (b) but using 2S-F aluminum instead of 24S-T4.

d. Same as (b) but using two stamped 2S inserts in each cone.

e. Same as (b) except aluminum is sprayed (metalized) into inside of cone and then machined to final dimensions.

4. Effect of Internal Tee Contour. Two new designs, in which the length of the .875-inch bore of the DRC314HW11 tee is shortened, are to be compared.

FUZES

Testing T267 Type Base Elements

The last reported test firing of the T267 base elements (Page 21 of Thirty-Fifth Progress Report) was unsatisfactory and for this reason the remaining elements of the lot were subjected to a careful inspection.

It was discovered that the holes for the setback pins were not deep enough by .010 in. This permitted a condition whereby function could occur only by compressing the setback spring to less than its solid height. This is only possible by the overlapping of the coils.

The holes for the setback pins were drilled .020 in deeper. Ten rounds with the thus revised base elements were fired at Erie Ordnance Depot under the same conditions as the previous unsatisfactory test. Nine rounds set superquick functioned superquick. One round set delay failed to function. The firing record is given in Table XVII.

In the attempt to locate the difficulty in the delay functioning the explosive train was investigated. Test fuze slugs were fired in an air gun and it was discovered that the delay detonator was firing properly but the next unit of the explosive train was not being initiated consistently. To correct this situation the train was altered by removing the tetryl lead, filling the resultant space with an aluminum plug, altering the detonator sleeve, and inserting an M7 relay as shown in Fig. 33. This system functioned well in air gun tests.

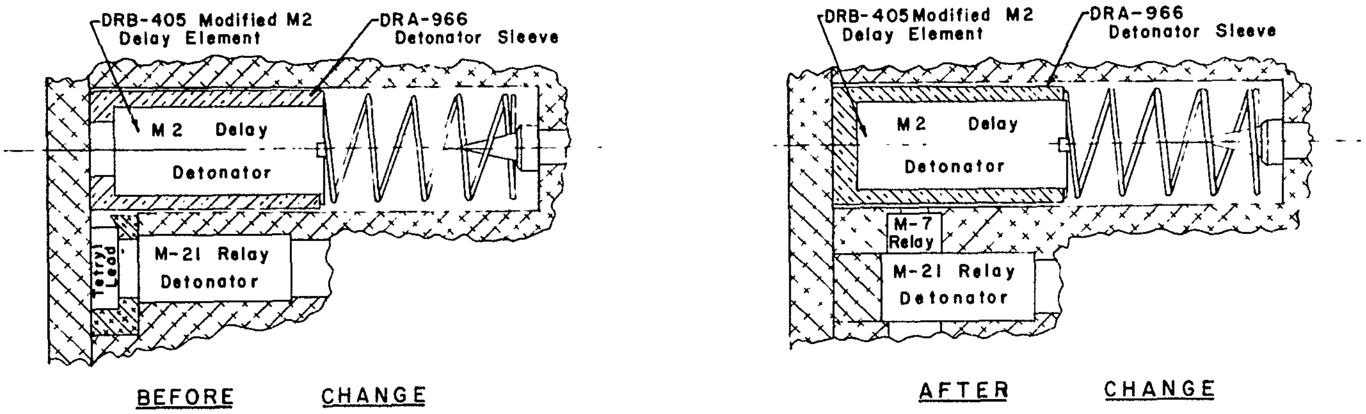


Fig. 33. Alterations in Explosive Train.

Future Program

1. Modify the remaining T267 fuzes to accept the M-7 relay and test fire the system at Erie Ordnance Depot.

2. Begin fabrication of a new lot of fuzes incorporating the changes indicated by the investigations this report period.

Table XVII
Firing Record
Functioning Test With T267 Fuze

Date of Test July 9, 1953

Purpose of Test To determine efficiency of T267E14 fuze

PROJECTILE

Model T138
Type E57
Weight 172 lbs nom.
C.G. Location ——
Bourrelet Dia 4.132 $^{-.002}$ in
Special Features T267E14 fuze system

TEST GUN

Model T137E3
Type 105mm Recoilless
Serial No 28
Chamber 23-C-120-L
Bushing (Vent) 22-C-209-D
Tube 22-8-775-B, Twist 1-200
Sighting Equipment M17 modified Telescope
Mount
Type T152E4
Serial 13
Solenoid Mechanical Firing System

MISCELLANEOUS DATA

Range 200 yds 4 in. Bursting Screen
Propellant
Type M10 MP Web .0335 in. Weight 7 lb 14 oz.
Lot No PA 30239
Primer M57
Shell Case T52E1
Liner Polyethylene
Temperatures
Magazine Max 70°F Min 70°F Present 70°F
Loading Room 70°F Ambient 73°F

Round No		Fuze No.	Proj Weight (lb.)	Powder Charge (lb-oz)	Wind Vel. & Dir	Chamber Pressure (lb/sq in)	Muzzle Velocity ft/sec		Elev (mils)	Azimuth (mils)	Position of Hit		Corrected Position of Hit — mils		Recoil (in)	Observations
							Instr	Actual			Vert	Horiz.	Vert.	Horiz.		
5232	1	30														Functioned at Target
5233	2	31														do.
5234	3	38														do.
5235	4	42														do.
5236	5	48														do.
5237	6	53														do.
5238	7	57														do.
5239	8	52														do.
5240	9	60														Hit target, but functioning not witnessed.
5241	10	63														Functioned at target

Note: Rounds 2 (31) and 10 (63) were assumed to function at target when a smoke smudge appeared, no flash was observed.
Round no. 9 was set for delay, all other rounds set for super quick action.
This test also used to check performance of electronic switch.
No velocities or pressures taken.

Proof Director J. Chaney
Observers W. Russell

Signed Paul J. Dacko

MANUFACTURING SUMMARY

In addition to the experimental material prepared for the research and development work under contracts DA-33-019-ORD-33 and DA-33-019-ORD-1202, described in preceding progress reports and in the preceding pages of this report, the following have been manufactured and shipped to the installations indicated.

Firestone's Defense Research Division, in shipping these items, transfers custody and control of the items to the receiving agencies. However, personnel of Defense Research Division will continue to collaborate with personnel of the other installations.

I. Cartridges, T119E11, Metal Parts Assembly, w/o Fuze T208E7

Prior to July 1, 1953	5985	All Shipments
July 2, 1953	300 (Inert)	Milan Arsenal
July 9, 1953	300 (Live)	Milan Arsenal
July 13, 1953	10 (Live)	Picatinny Arsenal
July 16, 1953	300 (Inert)	Milan Arsenal
July 16, 1953	100 (Live)	Milan Arsenal
July 24, 1953	300 (Inert)	Picatinny Arsenal
July 31, 1953	200 (Live)	Picatinny Arsenal
July 31, 1953	200 (Inert)	Picatinny Arsenal
Total	7695	

II. Rifles, T170E1 for ONTOS

Prior to June 30, 1953	24	Aberdeen Proving Ground
June 30, 1953	6	" " "

III. Mounts, T173, and T26 Tripod for ONTOS

Prior to June 15, 1953	1	Allis-Chalmers
June 23, 1953	1	" "

IV. BAT Systems, Less Jeep (T170E1 Rifles, T149E3 Mounts)

Prior to July 1, 1953	5	Aberdeen Proving Ground
July 13, 1953	1	Harvey Machine
July 31, 1953	3	Aberdeen Proving Ground

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